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Yeast's impact on wine aroma

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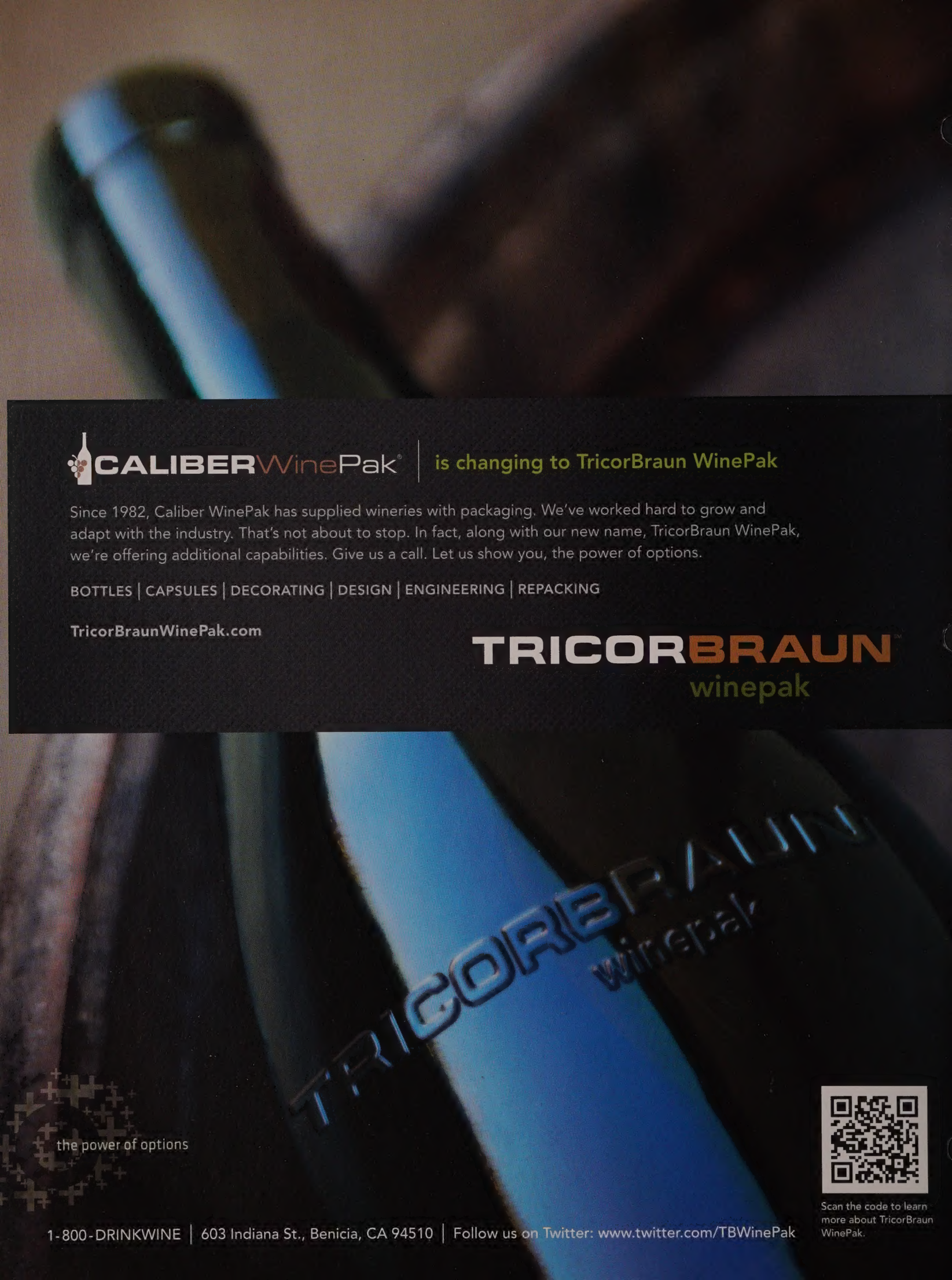
Green design – NINER WINE ESTATES red wine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Cover Photo: Niner Wine Estates (Paso Robles, CA). Photo by Tom Power.

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Paso Robles, CA

GREEN DESIGN for RED WINE

BY Tim Mark Woodle, AIA, Principal,
Steven D. Pults AIA & Associates, LLP., San Luis Obispo, CA

GREEN DESIGN is arguably one of the biggest trends of the upcoming decade, following intense growth within the viticulture sector in California. This concept was implemented in one of the newest wineries in Paso Robles, CA at Niner Wine Estates. Winemaking as a centuries-old practice has been combined with a state-of-the-art facility built according to "green design" principles.

Founded in 2001, Niner Wine Estates is dedicated to making the highest quality wines possible, using only estate-grown fruit. Owner Richard Niner's fondness for Paso Robles and the bounty of its land springs from his early upbringing on a rural farm in West Virginia. Niner Wine Estates is known for red wines, including their flagship blend of traditional Bordeaux varieties called Fog Catcher.

In the spring of 2004, Niner contacted Steven D. Pults, AIA & Associates to discuss design and construction of a winery that balanced environmental sustainability, innovative winemaking processes, and a world-class aesthetic.

In the initial meeting, Niner challenged the design team to work with the winemaking team on a process-based approach to winery design. The first step was to re-examine the fundamentals of a gravity-based red fruit sorting and delivery system.

The design focus then turned to researching existing state-of-the-art facilities, and evolved to a discussion of what would work best on this particular site, considering the team's winemaking goals.

ABOVE: Aerial view of Niner Winery (looking north) shows the layered roof forms, berms, and earth sheltering the structure into the natural slope. Fruit receiving occurs on the uphill side of the building. Newly planted vineyard on the hillside above the winery shows the chalky limestone soils at the site.

LEFT: Grape delivery, cluster sorting, destemming, berry sorting, crush rollers, and fruit delivery to one fermentor in circular array, below.

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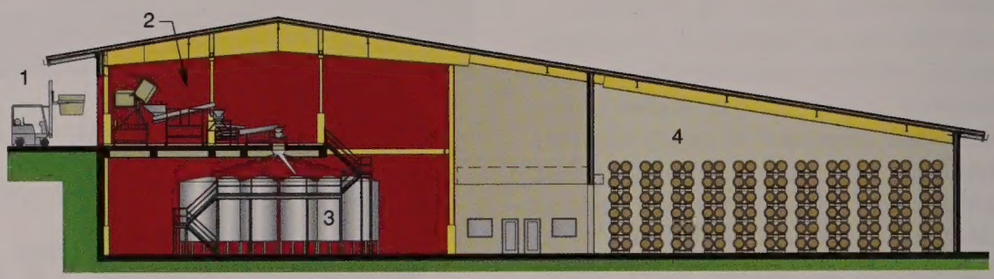
In the hospitality center, skylights flood the 1,923 square foot tasting room with natural light, with supplemental lighting supplied by energy-efficient fixtures. Walls and ceilings have high insulation values (R-23 stone walls and R-30 wood ceiling). The trussed roof allows the mechanical ductwork to be exposed, while providing efficient temperature control to the space. The 62 foot long tasting bar configuration allows a high level of interaction among customer/visitors.

The simple form, copper roof, and stone veneer of the hospitality building offer a dramatic aesthetic to passersby on Highway 46. Simple, agrarian forms were expressed in the building design, reminiscent of historic stone barns. The tasting room opens onto a large patio with a view of vineyards. A field of lavender emanates from the patio in concentric circles; the purple hues of the lavender provide striking color amidst the vineyards, oak woodlands, and olive groves.



Cutaway view includes: 1) Fruit receiving area, 2) Suspended sort + crush mezzanine, 3) Tank array in fermentation room, 4) Barrel room.

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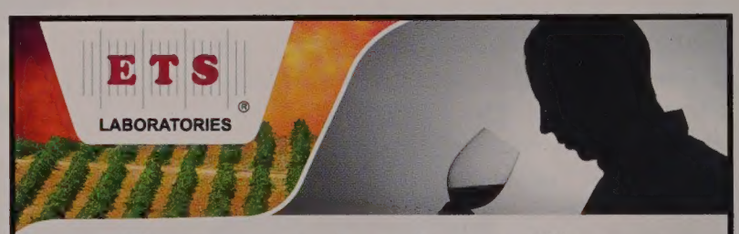

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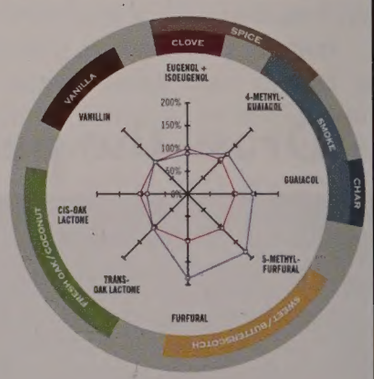

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Site design

The design focused on site evaluation and site master planning. The "L"-shaped parcel has frontage on Highway 46 West, a heavily traveled connection between Paso Robles and the coastal communities of San Luis Obispo County. The scenic highway corridor has become a mecca for wineries and tasting rooms.

The meadow site was selected for the hospitality center, for its location on scenic Highway 46, and the serene ambiance of the natural setting. In response to the character of the meadow, the architectural approach was to incorporate pure, simple, agrarian forms for the hospitality center.

North of the meadow are rolling hillsides newly planted with estate vineyards. An existing internal ranch road through these hills remained as a logical circulation spine through the property between the hospitality center and the production winery.

Winery support functions — including wastewater reclamation, rainfall catchment, fire suppression, and domestic and process water treatment, storage, and distribution systems — are accessed from this road, allowing them to be located out of view from onsite visitor serving areas and neighboring properties.

For the production winery, the design team selected a location on the ranch that best fit environmental and functional criteria. Site analysis identified a location on an eastern slope as the coolest part of the property, with the least exposure to summer sun, sufficient natural topography to create a semi-subterranean facility with ambient conditions similar to a cave, and the least desirable land for planting vineyards. The same slope that allowed the winery to be partially underground, also achieved the winemaker's request for a gravity-based sorting and delivery system.

Green design features

SOLAR ORIENTATION – Solar animation studies were performed utilizing VectorWorks CAD software and they confirmed that the natural orientation, topography, and vegetation

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Horizontal pipe struts connect the "floating" concrete mezzanine to concrete walls, as part of the multi-faceted structural system to stabilize the mezzanine and resist seismic loads. Transverse tensile rods brace the free-standing columns to prevent buckling. This integrated structural system allows the mezzanines to "float" without supporting columns below the mezzanines, which enabled the unique fruit sort and delivery system.

Extended overhang on west side of the production winery shades full bins of grapes picked the night before while waiting to be processed. The orientation of the winery and receiving area provides shade for the incoming fruit into the afternoon hours.

A 370-square foot analytical laboratory overlooks the fermentation room. Equipment includes a Denver Instrument Electronic Analytical Balance, Mettler Toledo T50 Titrator with auto sampler and sparging tube, Foss FIAstar™ 5000 Analyzer one-channel cassette with auto sampler 5027, and Anton Paar Alcolyzer. Lab utilities include deionized water, counter top valves, propane gas, vacuum, and nitrogen gas.

at the production winery location would provide significant shading of the structure and fruit receiving area for much of the harvest.

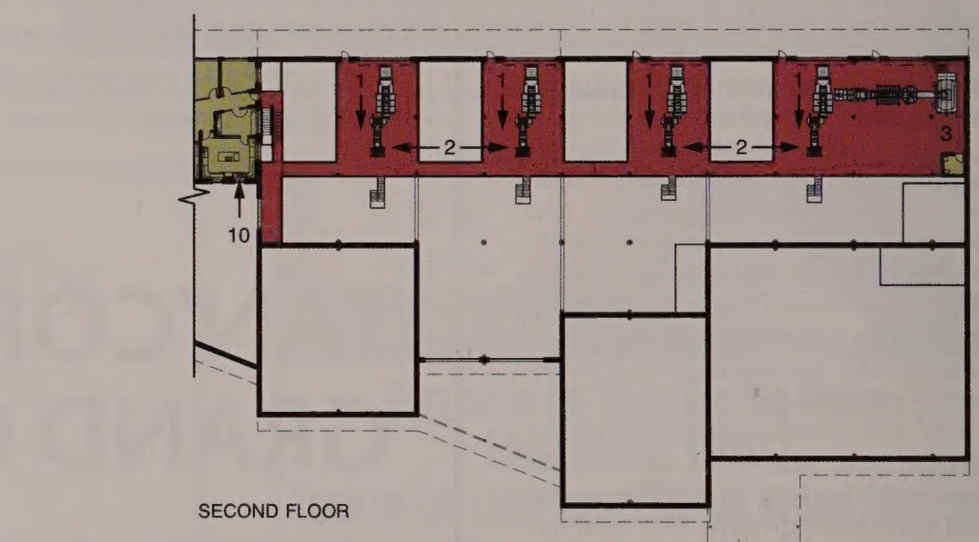
Shading of the fruit receiving area helps preserve the quality of the incoming fruit. Shading of the building in conjunction with appropriate roof slopes, materials, and orientation reduces solar heat gain, maintaining a stable indoor environment and using less energy for mechanical equipment.

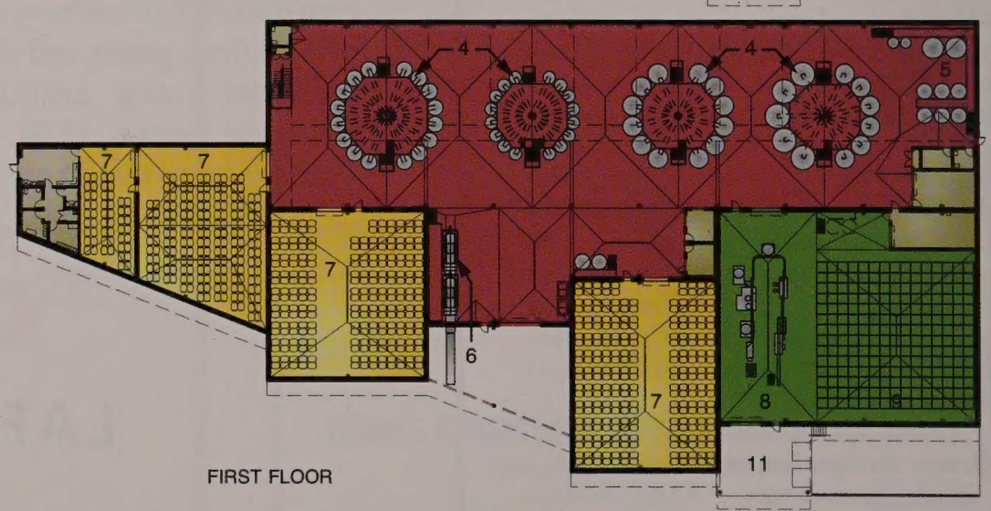
LANDSCAPING – To reduce water consumption and respect the agricultural roots of the property, ornamental landscaping was minimized. Instead, the majority of the landscaping is comprised of vineyards and two additional agricultural crops.

A dry-farmed barley field occupies the foreground of the hospitality center, as viewed by travelers on Highway 46. Lavender is grown in a radial field between the tasting room and Heart Hill. The lavender field composes the foreground view of Heart Hill itself, for visitors within the tasting room.

WATER RECLAMATION – The Wallace Group (San Luis Obispo, CA), designed the winery wastewater reclamation and rainwater collection systems. The wastewater treatment system was designed to meet state-mandated Waste Discharge Requirements issued by the State Water Resources Control Board.

The design includes cost-efficient aeration of a facultative pond using Air Diffusion Systems (ADS) fine-bubble aeration system that is well-suited to





Production winery floor plans include: 1) Grapes into facility, 2) Suspended sort/crush mezzanine for red grapes, 3) White grape press, 4) Four red fermentation tank arrays, 5) White wine fermentors, 6) Two red presses and pomace discharge, 7) Barrel room, 8) Future bottling line, 9) Case goods storage, 10) Lab, and 11) Loading Dock.

the environmental concerns of the project. An ADS system operates at 25% of the electrical requirements required by an industry-standard surface aerator. A constructed wetland is utilized for final treatment of the water.

In a rainwater recovery and blending pond (designed by the Wallace Group), multiple water sources are blended, including recovered rainwater from the winery roof, recycled process water, and well water. Onsite vineyards, other agricultural crops, and ornamental landscaping are irrigated from the rainwater recovery and blending pond. This water supplies approximately 15% of the estate vineyard's water demand.

"It is a low-energy, low-maintenance system that required some capital input," explains Rob Miller (Wallace Group). "It is the same theme as their wastewater processing system -- Invest up front, and over time, you get payback." The rainwater catchment is also a gravity-based system, except final pumping to the storage reservoir.

The rainwater catchment system is calculated to offset 100% of the domestic and winemaking process water demands for the facility. The winery roof area is approximately 58,700 square feet. Rainfall in the area varies, averaging 23 inches annually at the site.

In the winter of 2009/2010, a year with higher than normal rainfall, the catchment system flow meters recorded 800,000 gallons of captured rainwater. Total winery demand for water averaged 8.6 gallons per case, resulting in a system that has captured quantities greatly exceeding the facility demand, even at full anticipated production (50,000 cases). The wastewater and catchment systems contributed to the Leadership in Energy and Environmental Design (LEED) certification of the project.

Fruit processing

Working with winemaker Amanda Cramer and Niner project manager Tom Bower, P&L Specialties (Santa Rosa, CA) designed a red fruit handling system to be extremely gentle on the fruit. Half-ton bins of whole cluster fruit come into the facility on

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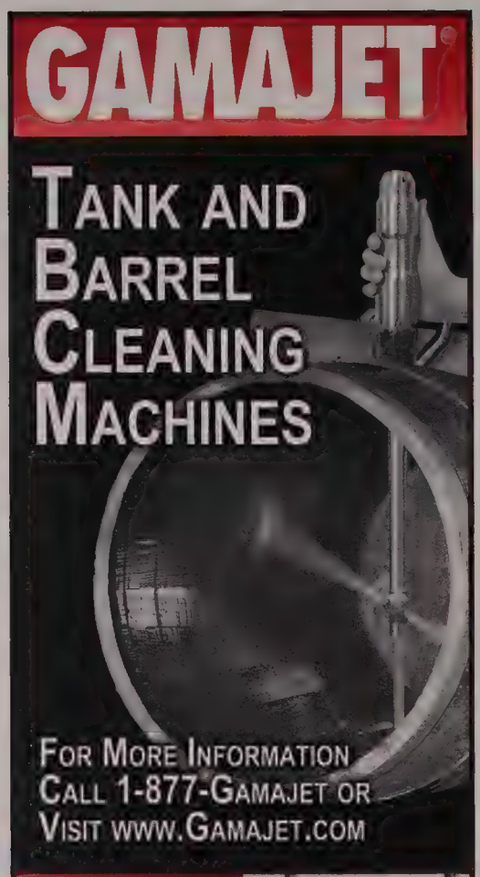

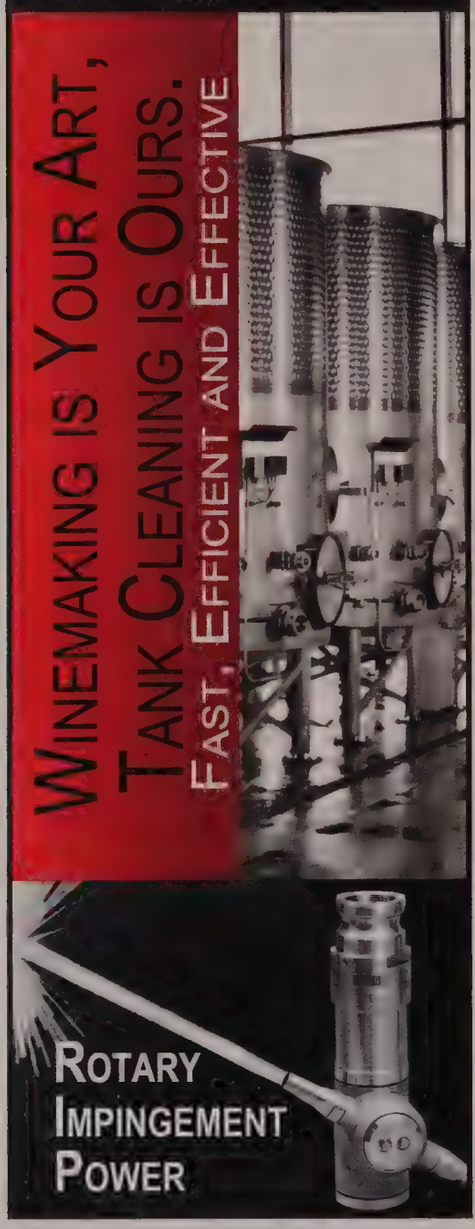

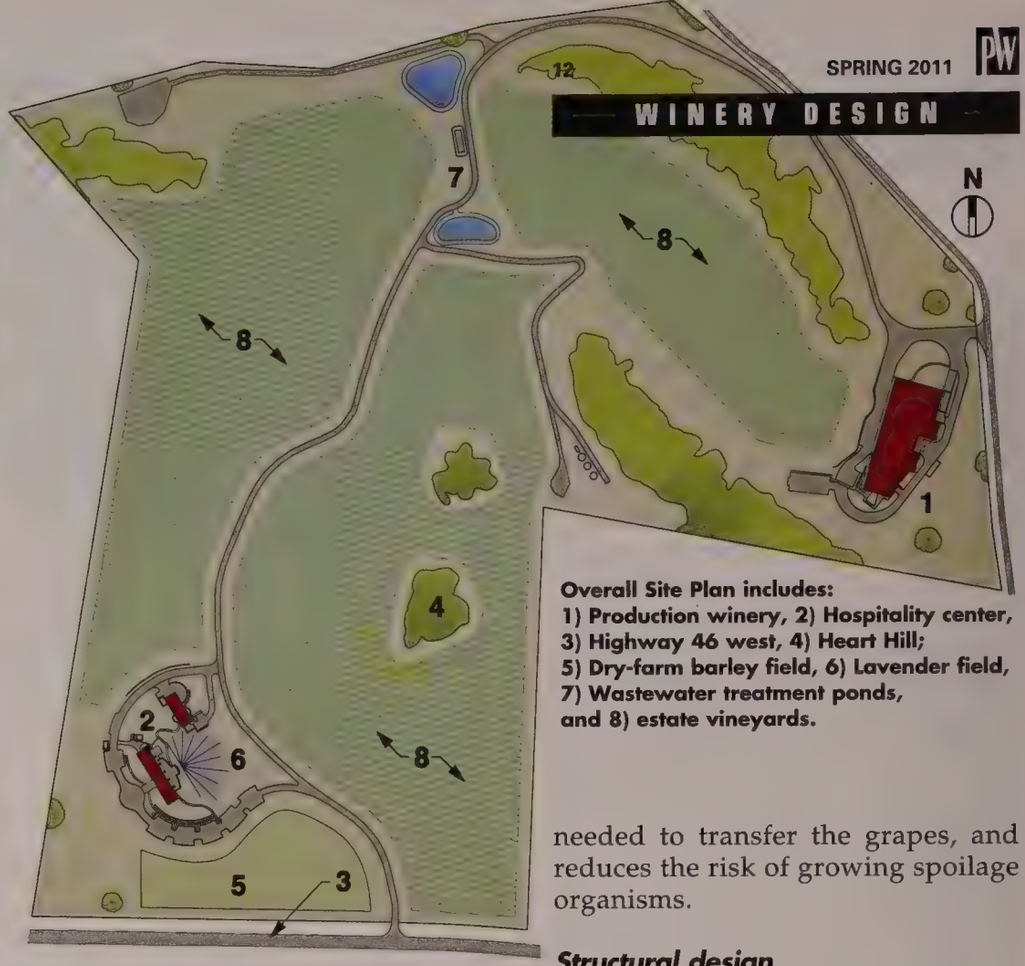

Overall Site Plan includes:
1) Production winery, 2) Hospitality center, 3) Highway 46 west, 4) Heart Hill; 5) Dry-farm barley field, 6) Lavender field, 7) Wastewater treatment ponds, and 8) estate vineyards.

an upper floor mezzanine from the fruit receiving area.

The bin dumper delivers fruit to an inclined whole cluster sorting table, destemmer, materials other than grapes (MOG) removal machine, berry sorting table, and then to crush-rollers that gently crush the fruit. "We adjust the rollers at the start of each lot of grapes to break the largest berries, while letting through about 30% whole berries," explains Cramer.

The fruit passes through an opening in the mezzanine floor and is delivered to fermentation tanks via a rotating conveyor. The conveyor is suspended from the underside of the mezzanine, and pivots in a 330° arc to fill tanks. There are four circular arrays of tanks, each with identical conveyor delivery from the mezzanine.

The four tank arrays have a total of 55 red fermentors with capacities of 3, 6, 12, or 18 tons. Each conveyor is 18 inches wide, 17 feet long, and sloped downward at 8°, to span from the opening in the mezzanine to the top access port of each tank. P&L Specialties coordinated and produced process engineering, final design, and implementation of the fruit delivery, sorting, and material flow systems.

Utilizing gravity to move fruit though the facility preserves fruit quality and reduces the energy needed to transfer the grapes, and reduces the risk of growing spoilage organisms.

Structural design

To avoid any structural obstructions to the rotating conveyors, conventional compression-based support columns below the mezzanine were not included in the design. Instead, Artisan Engineering (Arroyo Grande, CA) designed tensile columns to suspend the sorting/crush mezzanine from the main roof girders, creating a dramatic and very functional floating work area above the fermentation room in the production winery.

The cast-in-place concrete slab of the mezzanine weighs more than 650 tons (plus equipment, fruit, and personnel). The tensile columns supporting the concrete slab include an adjustment mechanism that permitted the slab to be pulled slightly up off the forms during initial construction, to achieve an appropriate slope for proper drainage.

The main steel girders (83 feet long and 6 feet deep when assembled) were shipped in pieces and bolted together on site. The roof diaphragm, constructed from diagonal pipe braces, had to include sufficient strength and ductility in addition to ample adjustment, to accommodate the inherent inaccuracies in the fabrication and erection of the oversized wall panels and roof girders.

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mary driver of the structural design for the production winery.

Structural design for the shell of the production winery had to focus on constructability and performance. Tilt-up concrete walls were sized on the ability of an available crane to lift and maneuver them into place.

The Thermomass™ system is a composite of an exterior concrete architectural shell, an interior concrete structural and thermal wall, and a closed cell Dow insulation core sandwiched between the two.

By placing the structural wall inboard of the insulation, the winery interior has a huge thermal flywheel, or thermal mass effect. This allows the building to perform thermally at an extraordinarily high level. While the steady state R-value of the wall system is approximately R-18, the effective value approaches R-30. The end result is a very efficient structure, particularly given the fact that it is also largely subterranean.

For the hospitality center, an Insulated Concrete Form (ICF) wall system was installed. The ICF walls consist of large-scale, modular, expanded polystyrene units filled with structural concrete that assemble quickly and provide high thermal efficiency. The roof envelope is composed of high R-value insulation system and metal roofing. The roof was designed for exemplary thermal performance by a combination of thermal mass, a well-insulated envelope, and materials that reduce heat gain.

Mechanical and Refrigeration systems

Production winery mechanical and refrigeration design was provided by Brummel-Myrick & Associates (San Luis Obispo, CA) and Applied Process Cooling Corporation (APPCO, Belmont, CA). One of the more challenging aspects of designing a mechanical system for a medium-size winery project is to provide maximum flexibility of performance for current operations and future requirements.

Flexibility is designed into every aspect of the refrigeration system at Niner Wine Estates, from providing 28°F glycol for cold stabilization in fermentation tanks, to heating a barrel storage area for malolactic fermentation, or doing both simultaneously. This flexibility provides whatever environment may be required at any given time during the year. A Johnson Controls Building Automation System ensures efficient management of all mechanical systems in all areas of the winery.

Mechanical systems were designed to meet today's efficiency expectations, while minimizing the amount of maintenance those systems will require to operate consistently at peak efficiency. High-efficiency air-cooled chillers uti-

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lize environmentally friendly R-410A refrigerant to provide chilled glycol and water for process and comfort cooling. Clean-burning boilers were specified for both space heating and process hot water systems.

Variable frequency drives were incorporated into air handler fans and hydronic pumps, to provide turn-down during periods of partial load to maximize energy savings. Night cooling systems, which are an inexpensive way to utilize temperature changes at night to naturally cool the building, were incorporated into all process and storage areas.

The mechanical systems as a whole are comprised of components that provide dependable, highly tunable environmental and process control, with low emissions and high turn-down capability. This combination results in minimizing the impact that Niner Wine Estates will have on the environment.

Lighting design

Lighting design was a significant part of the project. From the minimalist chandelier above the tasting bar, to the highly efficient production lighting, aesthetic qualities, performance, and efficiency were important elements of the comprehensive lighting design.

Lighting control systems are manually and automatically tunable. Occupancy and daylight sensors are key parts in energy management. All major spaces, except barrel rooms, have been designed with daylighting.

Daylighting is an important part of the LEED certification process, and was evaluated room by room. The production winery has 56 skylights (a total of 590 square feet) that provide natural lighting of most of the working spaces within the facility. The skylights are Velux-fixed curb-mount with laminated, low emissivity glazing, and are spaced in regular intervals to provide uniform lighting.

Clerestory windows (120 linear feet) allow natural light to enter the production winery without additional heat gain, due to overhang protection on the outside wall above these windows. The clerestories have PPG Solarban z50, 1-inch low emissivity insulated glazing.

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Lighting fixtures are equipped with daylight sensors that are calibrated to automatically turn the fixture on or off depending on lighting needs within the space. Daylighting contributes to, and in some locations, completely satisfies lighting demand, resulting in reduced energy consumption.

In addition, Niner Wine Estates purchases green power generated by renewable sources, such as wind and solar, and plans a future photovoltaic installation to assist in meeting energy needs.

The hospitality center is designed to bring the outside into the space by large windows that allow natural light into the tasting room and other adjacent areas, and provide dramatic views of the property. In addition, the flooring extends from the inside of the tasting room out onto the terrace, creating a seamless connection between the interior and exterior spaces.

LEED certification

Environmental stewardship, energy efficiency, and appropriate material selections were integral to the design from the beginning, but it was not until the latter stages of design that LEED certification was discussed. In Balance Green Consulting (San Luis Obispo, CA), evaluated the project to determine if there was potential to pursue LEED certification.

The initial assessment determined that certification was feasible, which served as a valuable tool to refine the design in many areas. In Balance Green Consulting navigated the LEED process and performed all of the required evaluation, monitoring, documentation, and commissioning associated with the project's LEED certification. The project has received silver level LEED certification from the U.S. Green Building Council in the first half of 2011.

Conclusion

The journey has been an incredibly satisfying one for the entire design team, winemaking team, and most importantly, Richard Niner. The Niner Wine Estates project is a testament to the feasibility of integrating sustainable concepts and innovative design to improve processes and enhance user experience throughout a new facility.

As we step into the new decade, Niner Wine Estates can serve as a benchmark for using "green design" to address many red winemaking challenges. ■

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SAN JOAQUIN VALLEY – CALIFORNIA

Integrating canopy management with mechanization

BY S. Kaan Kurtural
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Growers in the San Joaquin Valley (SJV) rely on large yields to be profitable. Despite their abundant volume (70% of winegrapes crushed), these winegrapes receive only about 25% of the winegrape farm receipts in California.

Producing high yields may be necessary, but achieving the optimum level of production can be an elusive goal for these growers. If yields are too low, the vineyard will not be financially sustainable.

However, if growers retain too many buds at pruning, the vines will become overcropped and out of balance – resulting in an undesirable canopy microclimate, leading to lower fruitfulness and fruit quality in the following year.

Adopting more mechanization is one way growers can lower farming costs. Canopy management practices traditionally done manually, such as dormant pruning, shoot thinning, shoot positioning, cluster thinning,[8] leaf removal,[7,30] and hedging, have significant effects on vine growth [3,8,10,20,25,26,29,1,2,5,6,21,24] and fruit quality[12,15,17,19,23,26,28] and can be done mechanically with potential cost savings.

Research is needed to test mechanization technologies and determine their short- and long-term effects on vine production and health.[10,18,21]

To help growers in the San Joaquin Valley, a four-year trial (2010 through 2013) was established to determine the effects of mechanical canopy management (dormant pruning, shoot thinning, and leaf removal) on vine production. The study will monitor canopy microclimate, cluster architecture, yield components, and ripening in Pinot Grigio and Syrah vineyards.

Results from this study will expand knowledge about growing Pinot Grigio and Syrah, provide information for growers on mechanical canopy management methods, and identify any potential problems for vine health associated with the new mechanized canopy management practices.

TOP LEFT: In Arvin, CA., an Oxbo Model 62084 leaf removal implement with a rotary blade gently vacuums the outer layer of Syrah leaves on the morning side (20 days post-bloom), into a drum where a rotary cutter shreds and discharges spent leaves onto vineyard floor.
TOP RIGHT: Oxbo implement removed an 18-inch tall leaf layer from the fruit zone of Syrah canopy on the morning side. Recently formed clusters, prior to flowering, are visible in the canopy.
ABOVE: Syrah clusters at 80% veraison, where an 18-inch tall window of leaves was removed from morning side of the vines.

Trial vineyards, treatments, and measurements

The trial is being conducted with Pinot Grigio (clone 03 on 1103P) and Syrah (clone 06 on SO4) in vineyards planted in 2003 and 1999, respectively. Both vineyards (Arvin, CA) are spaced

Figure 1. The 4-inch hedge retained as a result of mechanical dormant box-pruning applied with Oxbo 24-inch Sprawl Pruner heads (Model 63700), mounted to an Oxbo1210 single-row, tractor-mounted tool carrier in the Syrah vineyard.

7 x 11 feet (vine x row), trained to bilateral cordon in rows oriented north-south. The vineyards have been under mechanical management since Spring 2008, and the vines now produce consistent yields.

Replicated treatments were imposed to sustain yields of 8 to 9 tons per acre for Syrah and 8 to 10 tons per acre for Pinot Grigio. The vineyards are irrigated weekly by a drip system at 80% of evapotranspiration when mid-day leaf water potential is below -1.2 MPa (12 bars).

All other cultural practices are standard for the San Joaquin Valley and conducted according to University of California Cooperative Extension guidelines.

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In each vineyard, the trial is testing the effects of mechanically performed canopy management treatments consisting of two dormant pruning levels, three shoot density levels, and two leaf removal levels in four randomized complete blocks.

Two dormant pruning treatments:

- Hand spur-pruning of vines to retain 24 buds per vine on 12 spurs (3.5 buds per foot).
- Mechanical box-pruning to retain a 4-inch hedge of canes with a density of 15 spurs per foot of vine-row (approximately 2.5 to 3 buds per foot) using the implement in Figure 1.

Three shoot density treatments:

When inflorescence was fully developed, three shoot density treatments were applied using the implement in Figure 2.

- 7 count shoots per foot of vine-row (low shoot density).
- 10 count shoots per foot of vine-row (medium shoot density).
- 15 count shoots per foot of vine-row (high shoot density).

Two leaf removal treatments:

- No leaf removal (control).
- Leaf removal in the fruit zone on the east side of the canopy.

Leaves were removed with the implement (See photos on first page) in an 18-inch zone at 20 days after bloom.

The effects of these mechanical canopy management treatments on shoot density, canopy microclimate, fruit set, cluster architecture, yield, and fruit composition were evaluated. Not all data collected in the trial is presented here, but this report highlights the most important results.

2010 results

Effect of mechanical canopy management on shoot density – In the pruning treatments of Syrah vines, the number of count shoots, non-count shoots, and total shoots per foot retained was not affected by pruning method. However, for Pinot Grigio vines, the numbers of shoots was significantly higher in the mechanically-pruned treatment.

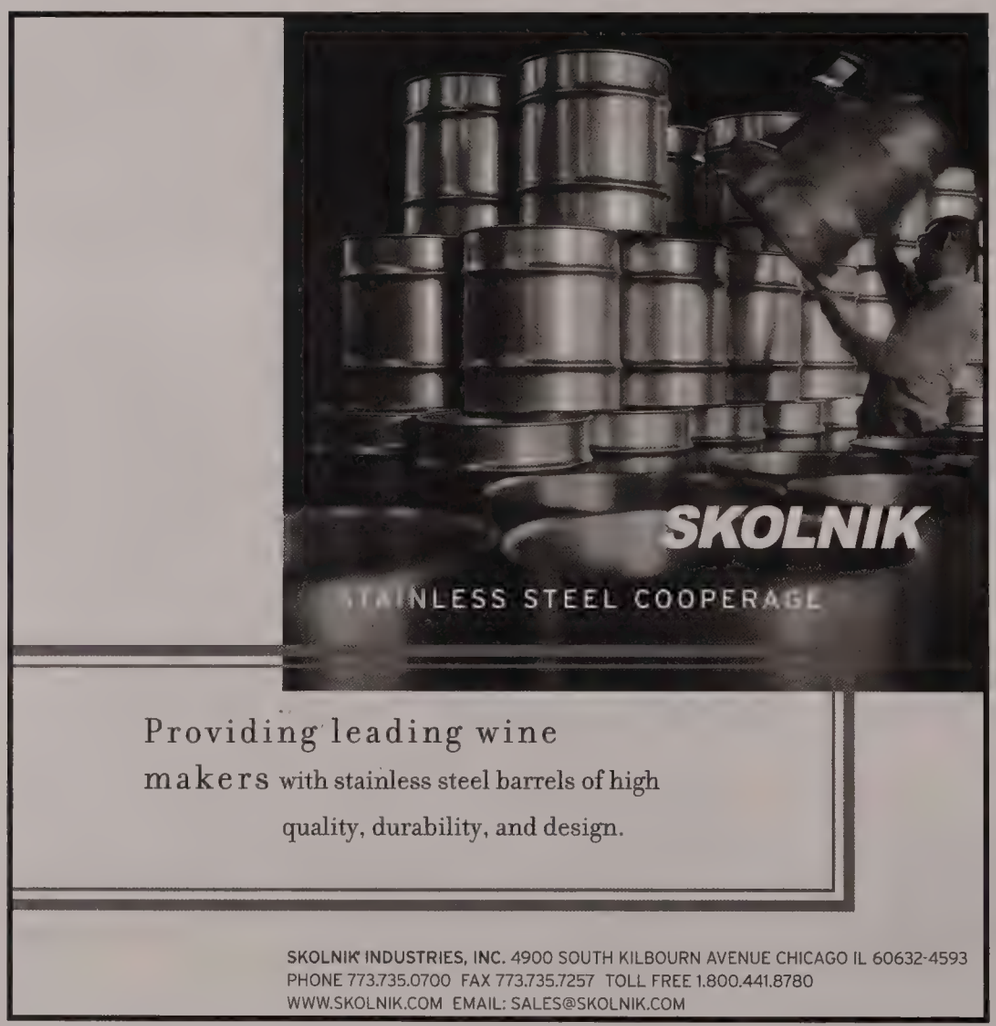
The shoot-thinning implement was used as needed to apply mechanical shoot-density treatments. In the Syrah vineyard, the density of count shoots, non-count shoots, and total number of shoots per foot of vine-row was influenced by shoot-thinning treatments. Shoot-thinning in the low and medium density treatments reduced the total number of shoots per foot of vine-row by about 30% when compared to high density treatment.

In Pinot Grigio, pruning and shoot-thinning treatments interacted to affect the count, non-count, and total shoots per foot of vine-row. Generally, mechanically box-pruned Pinot Grigio that was not shoot-thinned had the most count, non-count, and total shoots per foot of vine-row. Conversely, spur-pruned Pinot Grigio that was shoot-thinned to low density had the least count, non-count, and total shoots per foot of vine-row.

Effect of mechanical canopy management on canopy microclimate – The canopy microclimate was affected by some mechanical canopy management treatments. Leaf removal as a stand-alone treatment had significant effects on percent photosynthetic photon flux density (PPFD) transmittance, number of leaf layers, and percent canopy gaps in both Syrah and Pinot Grigio.

In Syrah, pruning and shoot-density treatments when applied as stand-alone methods did not affect canopy microclimate. However, when pruning, shoot-density treatment, and leaf removal are combined, the beneficial effects of integrating these three methods are evident in reduction of leaf layer numbers for Syrah. In Pinot Grigio, the integration of mechanical box-pruning and shoot-density treatment improved the PPFD transmittance. This also translated to more canopy gaps for mechanical box-pruning and low or medium shoot density in the Pinot Grigio canopies.

Effect of mechanical canopy management on fruit set – The pruning method, shoot density, and leaf removal treatments did not affect the number of berries per cluster or berry weight at set in Syrah. Leaf removal was the only treatment that increased the number of berries set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per cluster in the Syrah. A combination of medium shoot density and leaf removal improved berry set in Pinot Grigio.

Effect of canopy management on cluster architecture – Syrah cluster architecture at veraison was mostly affected by dormant pruning method and shoot density. The number of berries per length of rachis increased by 6% with the medium shoot density treatment, compared to low and high shoot density treatments.

Box-pruned Syrah vines had 11% less berry volume than spur-pruned vines. Increasing the shoot density per foot of vine-row with medium and high shoot density treatments decreased berry volume by 10% and 13%, compared to low shoot density treatment, respectively.

Effect of mechanical canopy management on yield – Mechanical box-pruning of Syrah vines produced higher yields (16%) with smaller berry size (12%) compared to vines spur-pruned by hand. The difference in yield came from the number of clusters that were borne on the shoots retained.

Mechanically box-pruned Pinot Grigio had 72% higher yields, with 13% smaller berry size. This was due to a significantly greater number of shoots per foot.

Mechanically shoot-thinned treatments significantly affected yields. In both varieties, the high shoot density treatment had significantly higher yields. Although there were no differences in yield in the low and medium shoot density treatments in Syrah, the high shoot density treatment had 12% more yield. In Pinot Grigio, the yield increased significantly with each increase in shoot density treatment.

Interactions – There were no effects of dormant pruning method, shoot density control, or leaf removal on the leaf area to fruit ratio of Syrah vines. This was probably due to the vigorous growth habit of Syrah, where long shoots with large leaves usually make up for the removal of shoots by shoot-thinning practices.

Shoot density and leaf removal interacted to affect the leaf area to fruit ratio of Pinot Grigio. High shoot density treatments with leaf removal did not have enough leaf area for the amount of fruit that was borne on the shoots. Conversely, vines receiving low shoot density treatments with no leaf removal had excess leaf area for the amount of fruit that was borne on the shoots.

Effect of canopy management on fruit composition – Hand spur-pruned Syrah vines reached the 24° Brix target one week prior to mechanically box-pruned vines.

During ripening, Syrah vines with low and medium shoot density treatments had higher Brix than those with high shoot density treatment. However, by 24° Brix, there was no

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Figure 4. A hand-held ceptometer was used to evaluate the amount of light filtering through the fruit zone of the canopy, to measure the microclimate of grapevines being tested.

difference among the three shoot density treatments. Leaf removal did not affect harvest date.

The hand spur-pruned Pinot Grigio vines had higher total soluble solids throughout ripening, compared to mechanically box-pruned vines, and reached 22° Brix two weeks earlier. Pinot Grigio vines with low and medium shoot density treatments were harvested two weeks prior to those with high shoot density. Leaf removal delayed harvest of Pinot Grigio vines by one week.

Take Home messages

Mechanical pruning is not enough to control yield. Mechanical pruning of the vines did not give adequate control of the shoot number

Oxbo de-leafer with two heads to remove leaves from the morning side of a vine row where only one head is in operation, depending on the direction of travel in the vineyard.

and production, because the number of non-count shoots was equal to or more than the number of count shoots retained at pruning. Although non-count shoots are not as fruitful, they are likely the cause of overcropping, and cannot be controlled by pruning.

Mechanical shoot-thinning is needed to adequately control yield. Without accurate shoot thinning, there is potential for excessive yields. The ability to mechanically reduce the number of non-count shoots makes achieving vine balance possible through mechanized farming practices.

When vines were mechanically shoot-thinned, the medium shoot density treatment resulted in optimum shoot density for these cultivars: 7 and 10 count shoots per foot for Syrah and Pinot Grigio, respectively.

Mechanical shoot-thinning techniques can be improved. For example, the total numbers of shoots retained were different than the intended treatments for count shoot control.

The three shoot density treatments called for 7, 10, and 15 count shoots per foot and the actual numbers were 12, 13, and 17 total shoots per foot for Syrah, and 17, 20, and 21 total shoots per foot for Pinot Grigio (very difficult to thoroughly thin on a 12-inch wide T-trellis).

Integrating at least two canopy management practices ensures improvement of the canopy microclimate. Pruning alone does not adequately control canopy microclimate for either cultivar. For Syrah, integrating pruning, shoot density, and leaf removal ensures fewer leaf layers.

Leaf removal as a stand-alone practice improves PPFD and percent canopy gaps for Syrah. For Pinot Grigio, a combination of dormant pruning and shoot-thinning, or leaf removal as a stand-alone treatment, improves PPFD transmittance or percent canopy gaps. Leaf removal was the only treat-

Figure 2. Shoot thinning was applied to Pinot Grigio vines using an Oxbo Cordon Brush (Model 62731) with auxiliary shoot-thinning heads. This cordon brush was mounted to an Oxbo 1210 single-row tractor-mounted tool carrier.

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ment to effectively control the leaf layer numbers for Pinot Grigio.

Crop load and leaf area had significant effects on ripening. Mechanically box-pruned vines were slower to ripen grapes than spur-pruned canopies, especially in Pinot Grigio, but there were no adverse effects on fruit composition at harvest.

The only adverse effect of mechanical canopy management was delayed ripening of Pinot Grigio with leaf removal, attributed to the reduced leaf area to fruit ratio achieved by this practice.

Overall, control of yield was achieved by integrating mechanized canopy management. Winegrapes are said to be in-balance when the vine can grow its fruit from flowering to a target °Brix within a given summation of degree days.

The leaf area to fruit ratio of Syrah fell between 1.2 m^2/kg for Syrah, and 1.0 m^2/kg for Pinot Grigio when these vines were box-pruned, adjusted to medium shoot density, and had leaf removal on the east (morning) side of the fruit zone. These leaf area to fruit ratios are in line with the 0.8 to 1.2 m^2 leaf area per kg of fruit needed to mature fruit trained to single-canopy trellis systems in the San Joaquin Valley.[16] ■

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Gary Grove, Professor, Washington State University, Prosser, WA
Rob Stoll, Assistant Professor, University of Utah

Grape powdery mildew (caused by *Erysiphe necator*) often develops explosively and can result in significant yield and quality losses, despite your best efforts. The threat of quality losses often leads to a low risk prophylactic regimen rather than a higher risk IPM approach.

Gary Grove and I have come to realize that you do not always have to spray when you think you do. *E. necator* inoculum was demonstrated to not always be present in a vineyard, and methods were developed to determine when it is present. These methods were then shown to be effective for initiating fungicide applications when *E. necator* is detected in the vineyard air. The applications resulted in 2.4 fewer fungicide applications without reducing disease control.

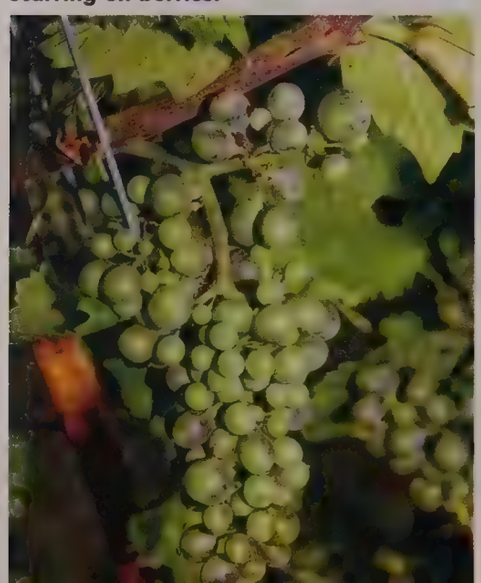
Discovering forecasting discrepancies

In the late 1990s, in some vineyards and in some years disease epidemics were observed in eastern Washington and western Oregon that did not progress according to our then-current understanding of the pathogen's biology. Grove noticed that powdery mildew in his production vineyard (eastern Washington) was often absent at the end of the season; even when events conspired to prevent optimal timing of fungicide applications.

My research group, in collaboration with Jay Pscheidt (Oregon State University), observed that disease forecasting models for grape powdery mildew often predicted ascospore release prior to bud burst, yet any disease was rarely seen until weeks after bud burst despite examining every leaf on every vine in untreated controls. Our groups independently concluded that these deviations were due to the lack of infective inoculum present in the vineyard air early in the growing season.

It was speculated that methods could be developed to determine when inoculum is present in the vineyard air, or models that would accurately predict when and where inoculum is present. This information would allow growers to better time fungicide applications and improve control and/or reduce losses.

Severely infected grape cluster – gray scarring on berries.



Developing new methods

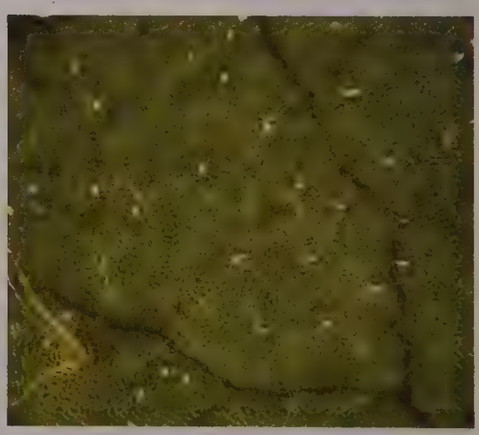
Grove's group started looking at inoculum concentration in vineyard air using the traditional and extremely laborious technique of visually counting spores trapped with the Burkard spore trap. They found long periods when powdery mildew spores were not trapped, which indicated that there were periods when disease would not spread. They also observed that it was extremely difficult to be sure that a mildew spore was from *E. necator* instead of some other powdery mildew in the vineyard or a nearby crop.

Flag shoot – severe infection of young shoot due to powdery mildew overwintering in the bud scale and infecting emerging shoot.

Tyrone Hall (in my research group), spent three years moving trap plants in and out of a vineyard every day, trying to understand under what conditions *E. necator* inoculum was present in the spring, and the conditions for ascospore release. Most of the ascospores were released prior to bud break, or after a period of warm weather in the spring.

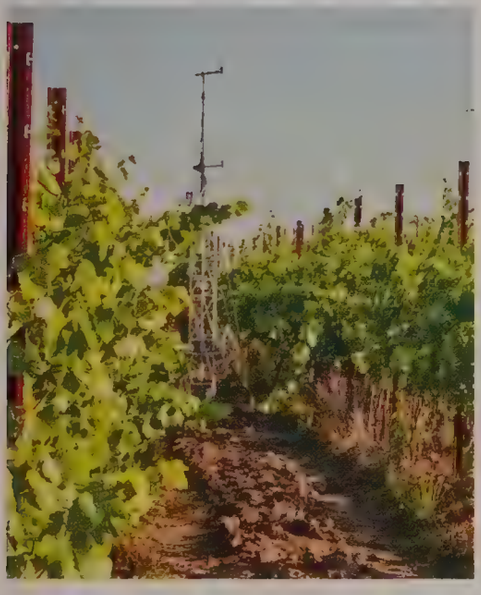
It appeared that the parameters put forth by D. Gadoury and R. Pearson (days with 0.1 inch of rain and an average temperature of 50°F) were well-suited for predicting the first ascospore release events, but not for later events.[3] However, the data set was still too limited to model weather data to accurately predict the second wave of ascospore release. It was also too expensive to continue working with trap plants.

Both groups began to explore other methods for determining when spores were available and ultimately decided that using PCR (polymerase chain reaction) to detect the DNA of *E. necator*



Powdery mildew 2.5 days after spores landing on leaf surface.

An impaction spore trap for monitoring airborne powdery mildew spores after shoot growth.



An impaction spore trap array and tower of sonic anemometers for monitoring dispersion plumes in a vineyard.

Impaction spore traps placed near the trunk to monitor for ascospore release.

from samples collected with spore traps would allow us to know whether the pathogen was present in the vineyard with significantly less cost than visual assessment of spore traps. (PCR enables researchers to quickly produce millions of copies of a specific DNA sequence.)

Jennifer Falacy (graduate student with Gary Grove) developed a qualitative PCR technique for the detection of *E. necator* in trap samples that could detect as few as 100 spores 100% of the time. Meanwhile Amy Peetz (in my group) pursued development of a cost-effective trap, improved DNA extraction techniques, and quantitative PCR.

Results from numerous spores traps were compared to results from

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RESEARCHERS: Dr. W. Douglas Gubler • Christopher N. Janousek • Ian S. Bay
DEPARTMENT OF PLANT PATHOLOGY • UNIVERSITY OF CALIFORNIA, DAVIS

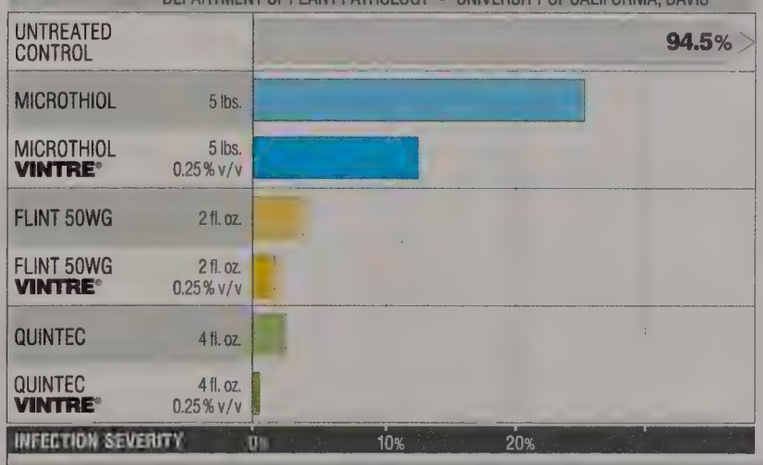

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TABLE 1

COSTS		PCR	qPCR	LAMP-PCR
Expendables	sample rods	$ 0.30	$ 0.30	$ 0.30
	primers	$ 0.18	$ 0.87	$ 1.36
	plastics	$ 0.53	$ 0.18	$ 0.50
	master mix	$ 0.56	$ 1.81	$ 1.91
	extraction kit	$ 3.95	$ 3.95	$ 0.15
	gel	$ 1.00	$ 1.00	$ -
	processing time	4 hours	4 hours	2 hours
	labor	3 hours @$40/hr	3 hours @$40/hr	0.5 hours @ $20/hr
Cost/sample - 10 samples/time		$18.52	$20.11	$10.22
Capital	trap	$300	$300	$ 300
	PCR	$16,000	$48,000	$1,900

a Burkard spore trap (considered the gold standard) in both research and commercial vineyards. Impaction traps (impinge particles on a sticky substrate) proved to be the most cost-effective.

Field results in eastern Washington indicated that some vineyards never developed mildew, while other vineyard managers could time their initial fungicide application when there had been 0.1 inch of rain with an average of 50°F for the day (basically the parameters developed by D. Gadoury and R. Pearson for New York in 1990).[3]

During this time various traps and mounting methods were tested, including mounting them on an ATV and driving rather fast through a vineyard. We found that the region of the vineyard with the most severe mildew pressure the previous year — or the perennial hotspot — is the best location to place the trap, and that early in the Spring the sample arms should be near and below the head or cordon, but above the canopy later in the season. However, it is still unclear how much acreage can be represented by a single trap — more on this later.

Testing new methods

At this point it looked like the research and work needed to be expanded to more commercial vineyards to further test our ideas. However, most commercial traps are

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expensive, require routine replacement of batteries, and could be difficult to mount within vineyards due to their size. A compact trap was developed that runs off batteries and a solar panel, and in which the sample head can be easily relocated without moving the trap (see Figure 1). The trap is built mostly with off-the-shelf materials, except for the sampling arm and circuit to regulate voltage and battery charging. Each trap costs about $200 in parts and $100 in labor to build. (Plans and instructions are available.) This is in contrast to a $5,000 Burkard trap.

While the qualitative PCR procedure worked well, some growers wondered about whether they could use quantitative data — how many spores were present in the air — to further refine their decision-making process. We were also interested in a quantitative measure of inoculum concentration, to further refine disease forecasting models.

A quantitative PCR (qPCR) procedure was developed that proved to be more sensitive than the qualitative PCR technique. The qPCR technique could detect 50 spores 100% of the time and 10 spores 75% of the time, but it was also more expensive (Table I), and sensitive to inhibitors associated with the myriad of things (spiders, bird feathers, bubblegum wrappers, pollen, pesticides, dust, etc.) that were co-sampled with the *E. necator* spores.

However, it still appeared that the qPCR technique would be cost-effective if growers could save two or three fungicide applications per growing season. In the Willamette Valley of Oregon, saving early Spring sprays also had the advantage of eliminating the need to drive tractors on very wet ground in hilly terrain.

To further develop these ideas into a practical method for growers, we worked extensively with five growers in the Willamette Valley during the 2007 – 2010 growing seasons. In the first year, biweekly spore trap and weekly disease scouting results were provided. In subsequent years, the five growers agreed to delay their initial fungicide application in partial or whole vineyard blocks (0.25 to 20 acres) until there was positive PCR detection for the presence of *E. necator*.

These trials resulted in an average 2.4 fewer fungicide applications per year compared with the grower's normal management program, without increasing disease development. Traps were placed in other vineyards, and the growers experimented with how they would use the data. One organic vineyard manager delayed applications over his entire vineyard (more than 100 acres) based on the trap data, with no difference in disease from a neighboring vineyard. Others used the data in conjunction with the Gubler/Thomas model to extend or tighten spray intervals.[2]

At this point, inoculum detection seemed to be extremely successful, but commercial implementation seemed

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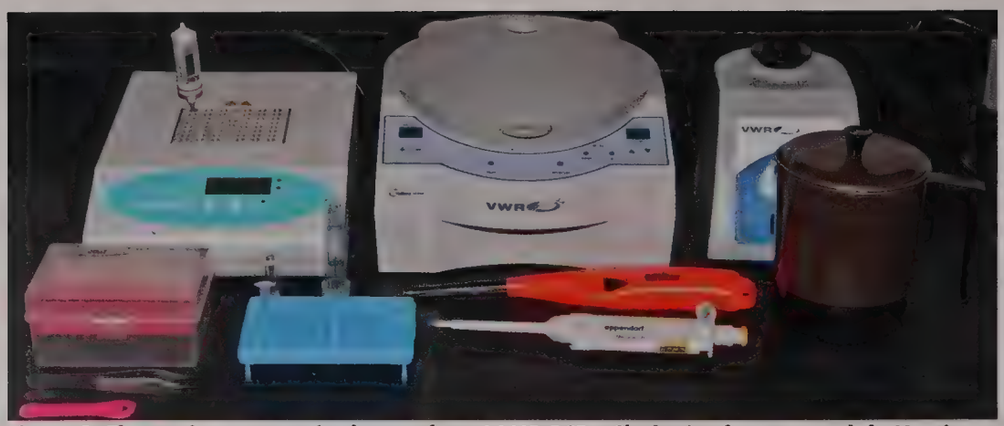


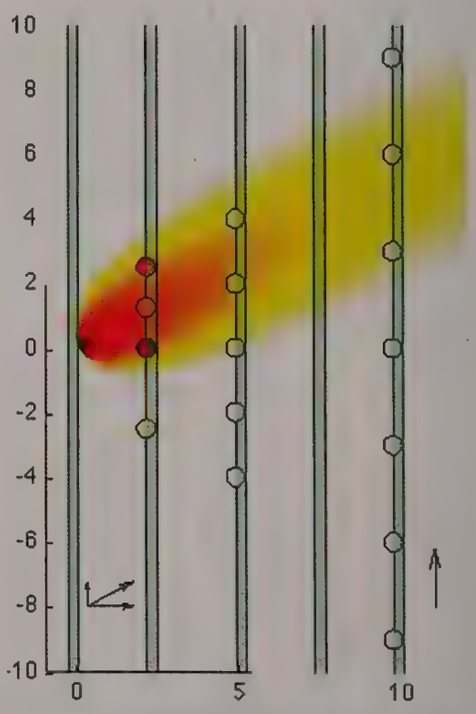
Figure 1: The equipment required to perform LAMP-PCR. Clockwise from upper left: Heating block, centrifuge, vortex, hotpot, 0-20µl pippetor, lighter, rack, plastic tips, forceps, microtube opener. Not shown are disposable gloves and non-frost free freezer.

unlikely due to the technical expertise and capital equipment required to run the PCR procedures (Table I). However, a new PCR technique (LAMP-PCR) showed promise in other systems as a cheap and effective alternative.

The medical community had developed a kit to test for malaria that could be transported without refrigeration, and be performed with very little equipment or skill. In the late summer of 2009, Dani Martin (in my group) began to develop a LAMP-PCR protocol and low cost DNA extraction technique (funded by Oregon Wine Board [OWB]). Testing of a grower-performed LAMP-PCR began in March 2010 thanks to funding from American Vineyard Foundation, Viticulture Consortium West, and OWB.

Three traps were placed side-by-side in a vineyard, and LAMP-PCR equipment and reagents (Figure 1) with five cooperating growers. One trap was used to collect qPCR assessment, and another for LAMP-PCR. The third trap was maintained by the grower, who performed LAMP-PCR using those samples in their office, winery, shed, or kitchen.

Growers were also provided with blind (they did not know what the results should be) spiked samples that contained 0, 1, 10, 100, or 1,000 conidia



How the concentation of spores in the air from an infection point at 0. Vine rows are oriented north/south.

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YEAST'S IMPACT ON SENSORY QUALITY OF WINE

BY Karien O'Kennedy, Anchor Yeast-South Africa

Wine yeast's primary purpose is to metabolize the sugar in grape juice to ethanol and carbon dioxide, the two main end products of fermentation. Small amounts of by-products are also formed which, despite their relatively low concentrations, can have a significant sensorial impact.

Additionally, certain grape components can be modified during the fermentation process, impacting the sensory attributes of the final wine. Below is a summary of the most important compounds formed or modified by yeast that can affect wine aroma and flavor.

Non-volatile acids

Acids can have both negative and positive effects on wine aroma and flavor, depending on the concentration and type of acid. Acid influences the following:

Survival and growth of micro-organisms;
Efficacy of anti-oxidants, anti-microbial agents, and enzyme additions;
Solubility of proteins and tartaric acid;
Efficacy of bentonite treatment;
Polymerization of color pigments,
Oxidative and browning reactions,
Freshness of certain wine styles.

The main non-volatile acids in wine are tartaric and malic. They comprise 90% of the titratable acidity in wine. The remainder of the total acid content is comprised of citric, succinic, and a few other acids which are available only in micro-quantities.

Acid imbalances can occur in must because of certain climatic conditions that influence the acid development in grape berries, and as a consequence of the metabolism of certain micro-organisms during fermentation. Yeast have no influence on the tartaric acid content of a must and wine, but can utilize or form malic acid. The same yeast that are capable of forming succinic acid are usually also the ones that form malic acid. Yeast can form up to 2 g/l succinic acid if conditions are favorable.

Succinic acid has a bitter taste in water, though this is usually not noticeable in wine, (due to a masking effect from tartaric acid). Succinic acid's main effect on wine flavor is of increased total acidity. Tartaric acid additions are complicated, as winemakers do not know beforehand how much succinic acid the yeast will produce before fermentation.

The lactic acid present in wines that have not undergone malolactic fermentation (MLF) is mainly derived from grapes. Yeast are not able to form significant amounts of lactic acid.

Volatile acids

This group of organic acids comprises about 10% to 15% of the total acids in wine. Of this, 90% is acetic acid. Acetic acid only starts to have a potential negative impact on the sensory quality of a wine above 0.7 g/l. Yeast differ in their ability to form acetic acid. Most yeast form between 0.2 to 0.7 g/l during fermentation.

Yeast form acetic acid to regenerate the co-factor, NADH, used during glycerol production at the start of fermentation, helping restore the yeast's redox balance.

Alcohols

ETHANOL – The main product of fermentation is ethanol. Ethanol influences the sensory properties of other wine components. It is responsible for the volatility of aromatic compounds.

When a wine's alcohol is very high, the wine smells "alcoholic" and has a "hot" finish, an unwanted sensory property. There are minor differences between sugar-to-alcohol conversions by yeast. In a 2007 study conducted by Lallemand, where the most commonly used white wine and red wine strains in the world were evaluated, the biggest difference in alcohol conversion observed was 0.51%. The majority of yeast strains had similar conversion rates. There is a vague indication that non-*Saccharomyces* yeasts might have a lower alcohol conversion, but this possibility is still being investigated (See Figure 1.)[2]

GLYCEROL – Glycerol is a colorless, odorless alcohol with a viscous nature. It is formed by yeast at the start of fermentation, and is found in dry wines in concentrations of 5 to 14 g/l. Red wines

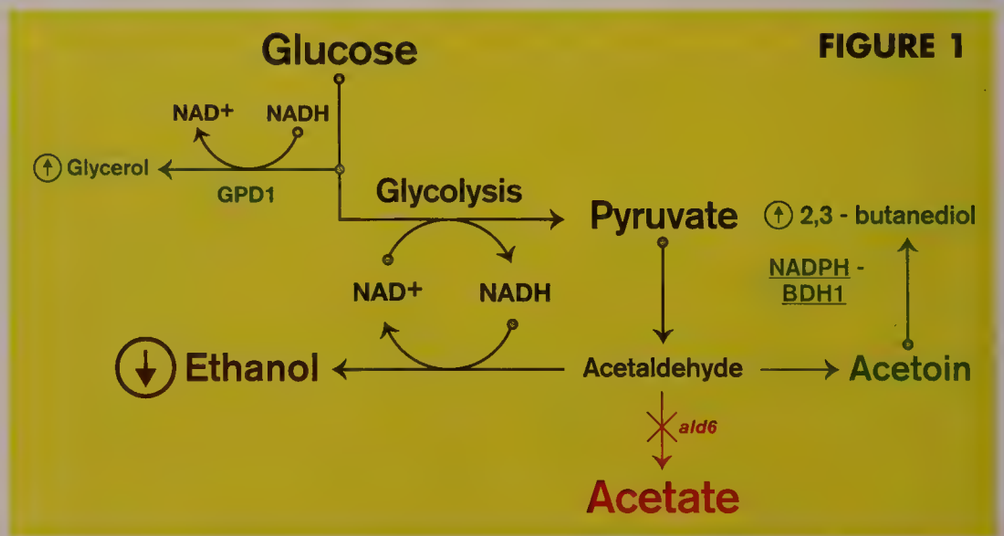

FIGURE 1

usually have a higher glycerol content than white wines. *Botrytis* wines can have concentrations as high as 25 g/l.

Glycerol has a sweet taste, and concentrations above 5.2 g/l can have an influence on the "sweetness" of a wine. It therefore contributes to the overall wine quality. Concentrations of 25.8 g/l and higher are needed to have an effect on viscosity (and therefore mouthfeel). Glycerol performs the following roles in yeast:

It forms part of lipid biosynthesis in the yeast cell membrane;

Glycerol production helps to restore the yeast's redox balance;

It protects the yeast against osmotic shock. This explains the higher concentrations found in sweet wines.

HIGHER ALCOHOLS – Yeast form higher alcohols from amino acids in grape juice. These alcohols can be both positive and negative for wine aromas. A concentration under 300 mg/l has a positive impact, and a concentration above 400 mg/l has a negative impact. The concentration found in wine depends on the amount of precursor molecules (amino acids) in the grapes, genetic ability of the yeast, ethanol concentration, and fermentation temperature. Excessive DAP additions reduce higher alcohol formation and can negatively influence wine quality.

Carbonyl compounds

ACETALDEHYDE is found in wine in concentrations of 10 to 75 mg/l. Concentrations above 100 mg/l have a negative impact on wine aroma and smell like bruised apple – a typical oxidation smell. Acetaldehyde is partly responsible for the "Golden delicious apple" aroma often smelled during fermentation. It usually disappears very quickly after fermentation. Yeast differ in their ability to form acetaldehyde.

DIACETYL has a buttery aroma and, in low concentrations, a nutty aroma. Yeast only form a very small amount of diacetyl (0.2 to 0.3 mg/l). Most diacetyl found in wines is derived from lactic acid bacteria.

Volatile phenols

The most well-known volatile phenols are 4-vinylgaiacol, 4-vinylphenol, 4-ethylgaiacol, and 4-ethylphenol. These phenols are off-odors and have a medicinal or barnyard-like smell, the typical "Brett" character.

Vinyl-phenols are a problem in white wines as they suppress the varietal character in low concentrations, and smell medicinal in high concentrations. They are formed by phenolic off-flavor (POF) positive yeast strains (yeast strains that have an active decarboxylase enzyme) when they are used in conjunction with an un-purified settling enzyme. Winemakers are advised to use white wine enzymes containing negligible

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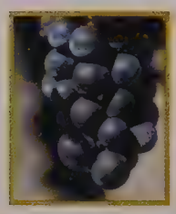

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levels of cinnamyl esterase, since most commercial wine yeasts are POF-positive.

Vinyl-phenols in red wine form stable complexes with anthocyanin, thereby stabilizing the color. They have no sensory impact on red wine aroma and are therefore a big positive. *Brettanomyces* activity, however, can lead to the formation of ethyl-phenols, which render a wine spoiled, according to some winemakers.

Esters

Ester formation during fermentation by wine yeast has a very big influence on wine aroma. An ester is a bond between an alcohol and a fatty acid. Esters smell like banana, pineapple, apple, pear, rose, floral, tropical, papaya (paw paw), strawberry, raspberry, cinnamon, prunes, etc. Yeasts differ in their ability to form esters. Ester formation is determined by fermentation temperature, the specific yeast, and the amount of precursors (amino acids and ethanol) in the must.

Winemakers often describe esters as "yeast or fermentation-derived aromas" and do not view them as "varietal" character. This view is not correct since the grape variety, the specific climatic conditions, and vintage play a big role in determining the concentration of amino acid precursors in the juice.

The most well-known esters are iso-amyl-acetate and ethyl-acetate. Iso-amyl-acetate smells like banana and pear, and ethyl-acetate in low concentrations (50 to 80 mg/l) smells fruity. In higher concentrations it can smell like acetone / nail polish remover. Wine yeasts normally form ethyl-acetate in the positive concentration spectrum. Excessive amounts of ethyl-acetate in wines are derived from acetic acid bacteria spoilage.

Sulfur compounds

These compounds have a very low sensory threshold and are, in general, very negative to wine quality. Sulfur compounds are divided into five groups: sulfides, polysulfides, heterocyclic sulfur compounds, thioesters, and thiols. Some of these compounds smell like cabbage, rotten egg, garlic, onion, and rubber. A small number of thiols, however, smell like guava, passion fruit, and grapefruit. They give Sauvignon Blanc, Chenin Blanc, and Colombard their unique varietal characters.

Yeast have a direct influence on the presence of sulfur compounds in wine. The positive sulfur aromas are an example of grape compounds modified by fermenting yeast to become flavor-active. In grapes these compounds are in precursor form and not aromatic. Yeast differ in their ability to release these aroma compounds.

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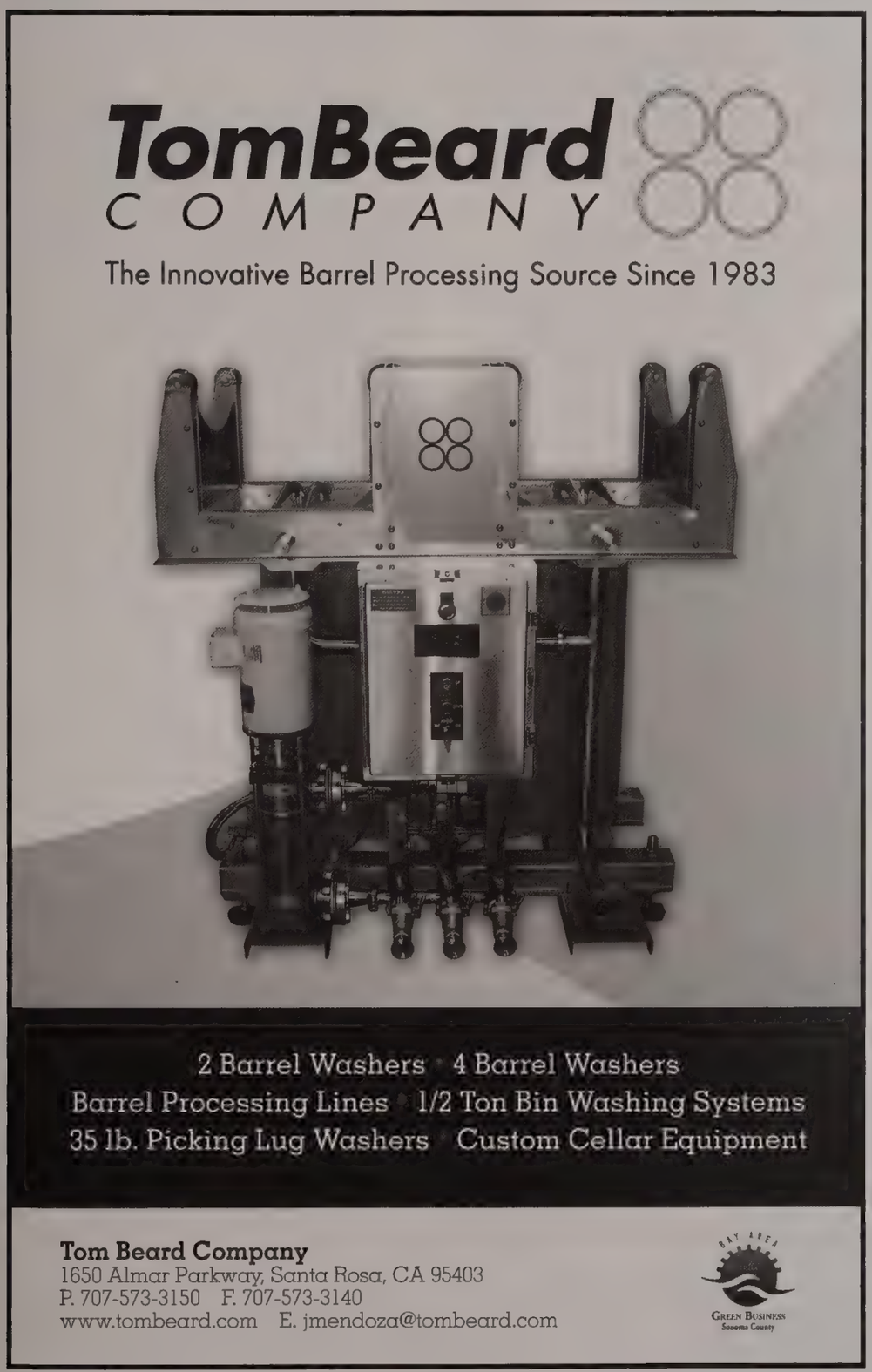
In the case of the negative sulfur aromas there are various factors determining whether or not they will form. Under certain conditions sulfur compounds can be converted from one form to another. H_2S can be removed by copper treatments and aeration but some other sulfur compounds cannot.

Conversion from one type of compound to another can occur after bottling. This means a wine that is fine at bottling can have sulfur-like off odors after six months, if a compound with a high sensory threshold is converted to a compound with a low sensory threshold. Copper unfortunately also removes the positive sulfur aromas, thereby affecting wine quality negatively. The best practice to control negative sulfur aromas in wine is to prevent them from forming in the first place by following a good yeast nutrient strategy.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Monoterpenes

Monoterpenes exist in two forms in grapes. One form is bound to a sugar molecule and is not aromatic. The free form (not bound to a sugar) is aromatic. This free form has fruity and floral-like aromas. Monoterpenes are most commonly found in Riesling, Gewurztraminer, and Muscat varieties. It can also be found to a lesser extent in Sauvignon Blanc, Chardonnay, and red grapes.

Yeast only have a limited effect on free monoterpene concentration in wines. Some yeast have β-Glucosidase activity, but this activity is not optimal at wine pH. Most grape monoterpenes are also di-glycosides (the monoterpene is linked to a glucose molecule and another type of sugar molecule). Sugar breakdown is sequential so the "other" sugar has to be removed first before the β-Glucosidase can get to the glucose molecule. Monoterpenes are nonetheless an example of grape compounds that can be modified by yeast to become more aromatic.

Conclusions

It is clear that yeast metabolites have a big influence on the sensory quality of a wine. Winemakers need to familiarize themselves with their vineyards' potential and adjust their yeast choice accordingly. What will work for one winery might not be the winning recipe for another. Good yeast nutrition will also ensure that optimal positive aroma compounds are formed, and, at the same time, prevent formation of negative aromas. ■

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Williams Selyem Estate

14 solar thermal collectors on the rooftop at Williams Selyem Estate Winery face due south on tilt racking to catch maximum solar exposure. Inside the collectors is copper piping filled with glycol to collect the heat, and send it down into the building's hot water system.

SOLAR HOT WATER

cost-effective solution for wineries

BY Tina Vierra

Solar hot water systems are a relatively low-cost way for wineries to use the power of the sun to reduce energy costs. Kunde Family Estate (Kenwood, CA) installed a solar thermal system in 2010, and Williams Selyem Estate Winery (Healdsburg, CA) built a new facility with barrel storage, a bottling line, and visitor center with a solar photovoltaic (PV) energy-generating system for electricity, and a solar thermal system for hot water generation.

Solar thermal systems

Solar photovoltaic (PV) panels (see *PWV*, January/February 2004, July/August 2005, January/February 2008) collect energy from direct daylight ultraviolet rays and send it to an inverter, which converts the energy to DC current that powers winery and vineyard electrical needs. Collected energy is most often stored in the existing utility energy grid until it is needed.

Solar thermal collectors are different from solar PV collectors in that they do not generate electricity — they transfer the sun's energy into heated liquid (glycol) that is then used to heat water. Solar thermal collectors are much less costly to install (on residential systems, about half the cost of solar PV), and they are four to five times as efficient — an 80% efficiency rating versus about 15% for photovoltaic.

The efficiency of solar thermal collectors varies using this equation:

Temperature of liquid in collector
– temperature of ambient air
= efficiency of the collector

The greater the difference between the two temperatures, the lower the efficiency of the collector.

Flat-plate solar thermal collectors (such as the ones installed at Kunde and Williams Selyem) consist of: 1) a dark flat-plate absorber of solar energy, 2) a transparent cover that allows solar energy to pass through but reduces heat losses, 3) a heat-transport fluid (glycol) flowing through copper tubes to accept heat from the absorber, and 4) a heat insulating backing.

The collector consists of a thin sheet of thermally stable copper to which a black or selective coating is applied, and a grid or coil of copper tubing held in an insulated casing with a glass or polycarbonate cover. Fluid is circulated through the tubing to transfer heat from the absorber to an insulated water tank.

Heat transfer to the hot water tank may be achieved directly, or though a heat exchanger. In the latter system, pumps circulate fluid through the copper tubes inside the collectors. This heated fluid then moves through a heat exchanger (either internal or external) to an insulated tank, where the fluid's heat is transferred to potable water. This solar pre-heated water is then fed into the building's regular water heater, reducing the amount of fuel (natural gas, electricity, or propane) typically used to heat water.

Some advantages of solar thermal systems are:

- Very high liquid temperatures may be achieved;
- By concentrating sunlight, these systems can get better energy efficiency than simple solar PV cells;
- During cloudy conditions and overnight, insulated tanks can store fluids heated by the collectors;
- Materials and installation time are less expensive than solar PV;

Kunde Family Estate

50 flat-plate solar thermal collectors on Kunde Family Estate's south-facing roof send hot glycol to a 1,040-gallon water storage tank inside the winery, heating enough water to cut the winery's annual bill for natural gas by half.

• Environmental benefits include reduced carbon emissions, reduced reliance on fossil fuels, and the marketing value of going "green" with solar thermal;

• System cost ROI/payback can be as little as five years for many wineries (this varies widely depending on the size of the system and hot water usage).

"Wineries use a lot of energy on the way to making that perfect wine," says Rob Smits of Citizen Green Solutions (Santa Rosa, CA), who installed the system at Kunde Family Estate. "They love solar energy savings, and how it fits their plan of long-term sustainability while giving them a competitive edge. Being a 'green winery' has a proven record of appealing to consumers who prefer to purchase beverages from environmentally responsible businesses.

"Fortunately, most wineries and breweries have warehouses with large, unshaded roofs, which are ideal for a solar PV or solar thermal

Heat exchanger (top of photo) at Kunde accepts heated glycol from the rooftop solar thermal array and sends the heat to the hot water loop in the winery. When the hot water in the system reaches 200°F or the winery is not using the hot water in the system, the glycol drains from collector pipes to a 120-gallon drain-back tank (bottom of photo) to prevent freezing or overheating.

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installation. Solar thermal systems make good sense for wineries and breweries, which spend a tremendous amount on fuels to heat water for cleaning and sterilization."

Financial incentives available as of Fall 2010 for solar thermal installations at wineries are:

- Cash rebates from California utility companies such as Pacific Gas & Electric (PG&E);
- MACRS (federal accelerated depreciation tax benefit);
- Federal investment tax credit of up to 30% of system cost;
- Some county-by-county programs and incentives, such as the Sonoma County Energy Efficiency Program (SCEIP).

Nick Stimmel, PG&E program administrator for the California Solar Initiative (CSI) thermal program, notes the residential solar thermal program was launched in May 2010, and the commercial solar thermal systems program in Fall 2010.

"The commercial solar thermal rebates are retroactive to all projects final (signed off by the local jurisdiction) after July 15, 2009, meeting the program requirements," Stimmel reports. "We are developing a calculator for this rebate. The system installer will input data for the system to be installed at a winery, and the calculator will generate an estimated energy savings and rebate amount to file with the utility."

Insulated copper piping brings glycol from Williams Selyem's solar collectors down to four, 175-gallon storage tanks with internal heat exchangers (1). The tanks feed the preheated water into the winery's propane-fueled water heater (2), reducing the amount of propane needed to keep water hot, or to heat water in the propane tank for winery needs.

Large solar thermal projects (larger than 250 kW thermal) will participate in a 70/30 "true-up" payment plan. Predicting system performance using the calculator, PG&E will pay 70% up front on that performance calculation. Then performance of the solar thermal system during its first year of operation will be metered, and the remaining incentive will be paid based on the "true-up" calculation. Basing part of the rebate on real performance of the system could mean larger rebates for a winery if the system performs well. Systems smaller than 250kW will receive a 100% rebate upon installation.

Handbooks for solar thermal installers, and rebate information for wineries, are available at www.pge.com/csithermal/.

Kunde Family Estate

Citizen Green Solutions installed a solar thermal system at Kunde Family Estate in early 2010. System output is estimated at 6 million BTUs per year, cutting the winery's average annual natural gas bill in half. The life of the system is estimated at 30 years, which will save Kunde about $95,000 in natural gas costs over that period.

"Our solar thermal system is used to

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heat water, which we then use directly in wine processing," says assistant winemaker Russ Fish. "This is the same type of system installed in many new homes to generate domestic hot water, and was very simple to install. Each of the 50 collectors we have should be able to heat 50 gallons of water by 50°F on a warm, sunny day."

Kunde's solar thermal system has:

- 50 flat-plate solar thermal collectors on the south-facing winery building roof (1,000 square feet of collector surface area);
- Insulated copper piping containing glycol;
- One 1,040-gallon storage tank;
- Two recirculation pumps (one for glycol, one for water);
- A 120-gallon drain-back tank to collect glycol from the collectors and pipes, to prevent overheating or freezing. When the storage tank reaches 200°F, the system shuts down automatically, and the glycol flows to the drain-back tank;
- A small electronic controller to control system functions, including temperature set-points, temperature display panels, heat exchanger, and storage tank.

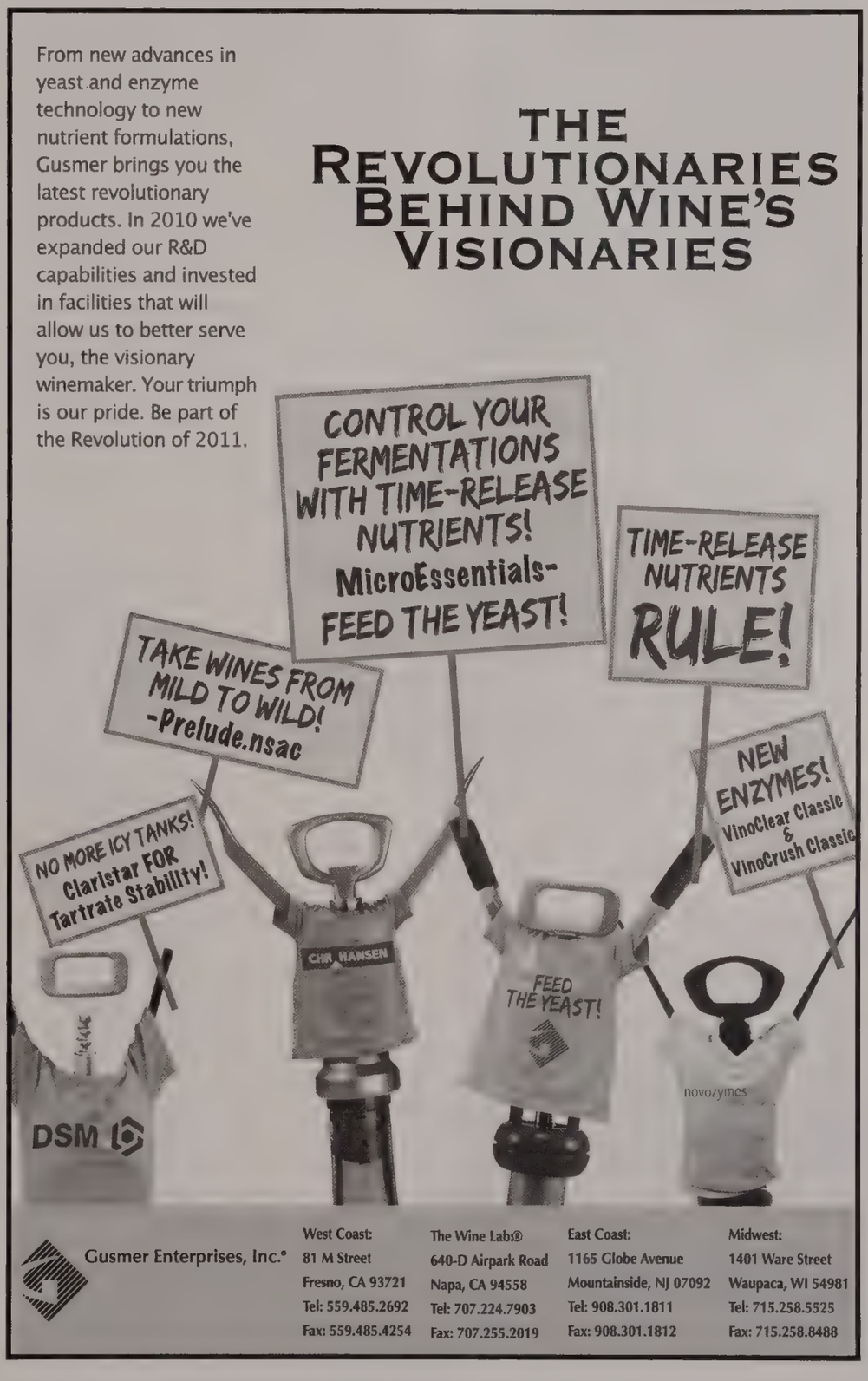
An external heat exchanger uses the heated glycol from the solar thermal system to heat water for the hot water loop at Kunde, boosting the temperature of hot water going to the boiler. Water can remain hot to 200°F in the storage tank for up to three days (it loses about 1°F per hour if no new hot water is introduced). The solar thermal system, at its peak production, should be able to generate up to 4,000 gallons of hot water for daily use at Kunde.

"The system's efficiency is highly dependent on the amount of solar radiation, and the daytime temperature," Fish reports. "On hot, sunny days, the storage tank will reach 200°F by early afternoon if we start from 60°F. On cooler, overcast days it may only reach 80°F to 100°F."

Hot water from the boiler is piped to Kunde's caves for barrel washing, and to the bottling line for sterilization. Early morning bottling runs take maximum advantage of the hot water generated the previous afternoon.

Fish planned that Kunde personnel try to do barrel washing on days when hot water is not needed to sanitize the bottling line, or in the afternoon when the solar thermal system is at top efficiency. The winery is researching the use of a steam generator as a method for sanitizing the bottling line and barrel cleaning. Pre-heated water from the solar thermal system could be used to feed the steam generator, cutting hot water use significantly.

Kunde's solar thermal system also pre-heats domestic hot water for the winery building, and a high-efficiency, tank-less, hybrid hot water heater was installed to boost the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solar-heated water when necessary.

Solar thermal system maintenance is performed by washing down the roof panels to remove dust two to three times per year, checking the glycol level every other year, and periodically inspecting the system for damage or leaks.

Williams Selyem Estate Winery

The new Williams Selyem Estate Winery center on Westside Road outside Healdsburg took three years to complete, and while crush and primary fermentation are still performed at nearby Allen Ranch, the new building contains barreled wine and case goods, a bottling line, and visitor center.

A 54kW solar PV system was installed by One Sun (Graton, CA) as two carport rooftops (one on the west side of a parking lot, and one on the east side). 226 PV panels are fixed at a 4-degree tilt, and seven string inverters convert DC current produced by the panels to AC current for use in the winery. The PV system is expected to power 25% to 35% of the facility's electrical needs, and earned a 30% federal tax credit and PG&E's CSI solar PV rebate.

A solar thermal system, installed by SunWater Solar (Richmond, CA), was activated in July 2010. The system components on the outside of the building are:

- 14 Heliodyne Gobi 408 collectors facing due south, with 448 square feet of collector area;
- 1.5-inch copper piping (L piping) with Armaflex neoprene insulation (3/4-inch wall) jacketing on the exterior.

Inside the winery, the system has:

- 4 Rheem 175-gallon solar hot water storage tanks with heat exchangers;
- 1 multi-speed solar pump;
- 1 mixing valve (controlling hot water temperature to prevent scalding);
- 1 Wi-Fi solar differential control (interface with online monitoring capabilities);
- 1 small expansion tank (5 to 10 gallons, to hold excess glycol, which expands with heat, so that it will not exceed the capacity in the pipes and collectors).

The 14 collectors mounted on the winery roof absorb the sun's rays, heating the glycol that circulates between the collectors and the four water storage tanks in the mechanical room. The heated glycol travels through piping from the collectors to the heat exchangers inside each solar hot water storage tank.

As the heated glycol passes through a heat exchanger, the heat is transferred to the water stored in the tanks. A pump pushes the cooled glycol back up to the collectors. The solar water tanks feed the winery's propane-fired water heater with solar pre-heated water, significantly reducing propane consumption.

The solar differential control is the "brains" of the thermal system. It turns the pumps in the solar thermal system on and off, and also logs system data. Because the control utilizes Wi-Fi (wireless Internet connectivity), winery operations can view system data anytime, on any computer that has an Internet connection.

Hot water produced by this system is used for barrel washing, wash-down of tanks, equipment, and floors at the facility, and bottling line/bottle sterilization before filling. It is also used for heating barrel storage rooms when needed, and for sterile cleaning (including four commercial dishwashers in the visitor center).

Domestic hot water (bathrooms, employee kitchen, lab, and tasting room sinks) is provided by 40-gallon domestic water heaters, not connected to the solar thermal system.

SunWater's "Polysun" analysis of the system shows that the winery can expect it to heat 650 gallons of water on an average day, approximately 182 million BTUs (equivalent to 2,000 gallons of propane) per year. With the cost of propane in Sonoma County hovering at $3 per gallon in 2010, Williams Selyem will save $6,000 annually on propane costs, and even more as fuel costs increase.

"The winery system is eligible for a 30% federal Investment Tax Credit," explains Justin Weil, President of SunWater Solar. "Winery owners

may also be able to take advantage of accelerated depreciation tax breaks. The system may also be eligible for the CSI-Thermal commercial rebate, expected in Fall 2010. When the rebate calculator for commercial solar thermal systems is announced, we will have a better idea of the rebate's value."

Conclusion

"It was an honor to help the Kunde family advance their sustainable winemaking practices," says Smits. "Their solar water heating system provides a model to other wineries wanting to reduce their utility bill and use the energy savings to pay for the system."

"We chose to install a solar thermal hot water system because of its efficiency and short investment payback," says Bob Cabral, general manager/winemaker at Williams Selyem. "I would recommend that all homes, businesses, and wineries seriously look into this cleaner energy source as our future. We felt that if everyone started doing a little bit at a time, we could hopefully break the oil usage cycle and secure a cleaner future for the next generation." ■

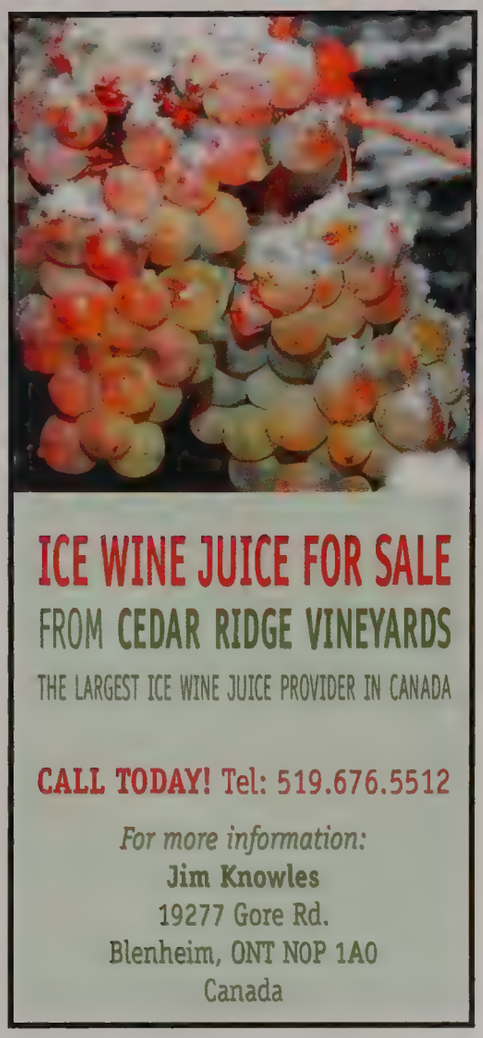
Resources:

Citizen Green Solutions (solar thermal installations): 900 College Ave., Santa Rosa, CA, 95404; tel: 707/576-1000; citizengreensolutions.com.

One Sun (solar PV installations): PO Box 532, Graton, CA, 95444; tel: 707/824-1951; fax: 707/634-1423.

Pacific Gas & Electric Company (California utility rebates and incentives): pge.com/wineries for general rebate information; pge.com/csithermal (for commercial solar thermal rebates).

SunWater Solar (solar thermal installations): 865 Marina Bay Parkway, Suite 39, Richmond, CA, 94804; tel: 510/233-0300; fax: 866/856-8867; sunwatersolar.com.



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SMART VITICULTURE *by Dr. Richard Smart*

Reducing CO_2, the *REAL* pollutant

In this age of environmental awareness, many in the wine sector are concerned about their environmental impact. Vineyards have received a major share of this concern, which has spawned different management modes of viticulture, to wit "organic" and, more perversely, "biodynamic."

Chemophobia is widespread in our society, and is the basic cause for such concern. However, in my opinion, much of this concern is not justified, about which I will write in a future column. In this column I want to try and focus grape and wine producers' attention on CO_2 emission, which I believe is the most grave pollution issue.

Why might such a statement be justified? I believe, as do many others, that carbon dioxide (CO_2) is the most important pollutant today. Major contributors to the increasing levels of atmospheric CO_2 include the burning of fossil fuels in energy production and transport, but agricultural activities, including grapegrowing and winemaking, are also a major source.

The majority of the world's climate scientists agree that recent evidence of global warming can be linked to increasing atmospheric CO_2 levels, increasing largely because of human activity.

The outcomes of a warmer world could be very considerable social and political chaos, wars for scarce resources like water, and other serious impacts on the way we live and where we work. Many readers will be aware of my concerns about the future of the world wine sector with a warmer planet, as presented in ***PWV Journal***, "Vines, wines, and more heat" (May/June 2008) and "Future of the wine sector" (July/August 2006).

Carbon neutral wineries?

Many wineries are now claiming to be carbon neutral, after accounting for the carbon inputs and outputs of production and distribution. Carbon neutrality is typically claimed by purchasing carbon credits, often associated with forestry. There are now a number of carbon calculators available to the wine sector, such as the International Wine Carbon Calculator Protocol, and one is available at the website of the Winemakers Federation, which has been developed with international cooperation: http://www.wfa.org.au/entwineaustralia/carbon_calculator.aspx.

But are such wineries truly carbon neutral? No, in my opinion, if they do not account for CO_2 emission in fermentation.

Carbon balance in vineyards and wineries

Carbon calculators today deal with minor value items in the overall annual carbon balance of a vineyard and winery operation, because such calculations ignore carbon dioxide uptake by vines, and carbon dioxide emission during fermentation.

I wrote an invited article focusing on climate change and wine in the November 2010 edition of the *Journal of Wine Research*. The aim of my article, "A lump of coal, a bunch of grapes...." was to show the similarity between the coal and the grapes, in the sense that they can both be seen as forms of stored carbon. Of course, coal is very old and its carbon comes from vegetal remains formed in the geological Carboniferous period, 290 to 350 million years ago.

Most carbon compounds in a cluster of grapes, on the other hand, are at most a few months old, mostly the product of recent photosynthetic fixation of atmospheric CO_2. Sugar is about one-quarter of the weight of grape berries, and during fermentation yeast produces alcohol and CO_2, which conventionally is vented to the atmosphere. In fact, many wineries buy CO_2 for use in sparging tanks, which is then also vented to the atmosphere! Are wineries carbon polluters?

The article quoted from a study by Damien Martin (1997), which was commissioned by the Wine Institute of New Zealand. The report can be found at the New Zealand Winegrowers website (www.nzwine.com/reports/). Martin made his calculations for the New Zealand wine sector, which was, at that time, very different from today. In 1997, there were only 6,015 hectares (15,038 acres) producing an average of 11.4 tons per hectare.

The summary of Martin's annual CO_2 budget of vineyards and wineries is in Table I. During grape production the net balance of CO_2 is fixation of 9.7 tons per hectare per annum. On the other hand, the table shows a positive emission of 0.98 ton per hectare in the winery, and an additional 0.59 ton of CO_2 is emitted during winery waste management.

Overall, according to Martin's budget, **grape and wine production fixes more CO_2 than it releases.** This leads to consideration of the point of contention that agriculture is ignored in calculations of carbon budgets as they are currently used, although this situation may now change.

Martin calculates that a moderate vigor vineyard absorbs around 9 tons of CO_2 per hectare, and that the tractor-row cover crop may fix another 3 tons of CO_2 per hectare per year. The most important carbon storage in a vineyard is in grape shoots and leaves at 53% of the total. The next most important is in grape sugar at 32%, while minor storage is in seeds, pulp, trunk and root growth. Martin found that some CO_2 is released as leaves and prunings are broken down by microbes, but that some is retained as humus in the soil.

The most significant emission of CO_2 in the winery is during alcoholic fermentation. About 10% of the weight of grapes at 23% sugar is produced as CO_2. Small amounts

Table I: Summary of net annual budget of carbon dioxide (tons per hectare per year) for vineyards and wineries*

	Fixation	Emission	Balance
Grape production	-12.1	2.40	-9.70
Wine production	-0.01	0.99	0.98
Winery waste management	0.00	0.59	0.59
Total	**-12.11**	**3.98**	**-8.13**

***Negative values represent a net uptake of atmospheric CO_2. From D. Martin (1997), "The carbon dioxide budget of the New Zealand grape and wine industry." Unpublished report commissioned by Wine Institute of New Zealand Ltd.**

of CO_2 are dissolved in wine and given off by malolactic fermentation. But alcoholic fermentation represents around 10% of the net CO_2 fixed by the vineyard system, and is the biggest emission.

These interesting calculations give rise to a consideration of the true carbon balance for vineyards and wineries. I had a recent conversation with Dr. Karl Forsyth, senior engineer at the Australian Wine Research Institute (AWRI) and an authority on carbon accounting, and he noted some reservations about Martin's work, especially about the soil carbon accounting.

Research needed

Increasing carbon fixation and sequestration in the vineyard – This seems to be an obvious topic for research. Given that grapevine shoots and leaves are the dominant form of stored carbon, how can these be incorporated in the soil — hopefully in a stable form that will not produce CO_2?

Much thought is currently being given to sequestering soil carbon in agriculture. Could fallen leaves and petioles be gathered and turned into more stable forms of carbon? Can the same be done for prunings? What role can composting and biochar play in this process?

Since vineyards will inevitably run down soil organic matter (as has been shown by studies in California and New Zealand), how can these levels be raised? How might soil carbon be sequestered, and not just turned back to CO_2 by microbes?

Reducing CO_2 losses in winery

The principal forms of CO_2 loss in the winery are from fermentation and wastewater treatment. I am told that breweries capture CO_2 from fermentation, which is subsequently used in sparging tanks or maybe even sold. This is easy for breweries because they have fermentation all year long, but it is not so easy for wineries, with only two to three months per year of harvest.

Compressing CO_2 for subsequent reuse involves considerable energy costs. However, it seems to me that this is a subject worthy of further research. Brown Brothers Winery in Australia has a passive collection system that does offer some reuse of fermentation-derived CO_2 for sparging.

Miguel Torres spoke at the Second World Climate Change and Wine Conference (2010) in Barcelona. The Torres Company of Spain is probably the world's most advanced winery in terms of reducing CO_2 emissions. The website www.rtcc.org/2010/html/miguel-torres.html "Respond to climate change," and the Torres website www.torres.es list actions a winery can take to reduce these emissions. Can your enterprise match these?

Actions include participating in a wind turbine park of 2.8 mega watts; 2,008 photovoltaic cells covering 1.2 hectares; solar panels producing 50% of hot water needs; an electric delivery van for local deliveries; replacing a fleet of more than 100 vehicles with hybrid vehicles over four years; wastewater reuse and rainwater storage; reducing energy use by installing underground warehouses; utilizing biomass of marc and stalks to produce electricity, heat, and refrigeration; and using algal cultures and solar energy to create biomass from CO_2 produced in fermentation.

Martin suggests that the CO_2 loss in wastewater treatment is high, over half that of fermentation loss. How could this be improved? Could constructed wetlands help here, using solar energy to produce biomass in the process? It seems worthy of research.

I am also aware of an Australian company claiming to capture fermentation CO_2, with the added benefit of extracting volatile wine aromas. See www.greenlime.com.au. Were such technology developed further, the need for much winery refrigeration would be obviated, as there would be an alternative to volatile aroma retention due to slow and cold fermentation.

Conclusion

In the Loire Valley in France, a long-term study of organic amendments carried out over 28 years showed that crushed vine prunings were preferable to mushroom compost and cow manure as an organic matter soil amendment in vineyards. Cow manure in particular had negative effects on the environment, vine growth, yield, and wine quality. Yet, animal manures, despite being major contributors to increased atmospheric CO_2 levels, are still preferred in "organic" viticulture.

It is time to rethink the role of carbon in vineyards and wineries, and for the world wine sector to hold its head up as being concerned about the greatest environmental pollutant of all — carbon dioxide. ■

Reference

D. Martin. 1997. "The carbon dioxide budget of the New Zealand grape and wine industry." Unpublished report commissioned by Wine Institute of New Zealand Ltd.

Dr. Richard Smart is rewriting and thoroughly revising Sunlight into Wine. *He is happy to receive statements from growers and winemakers about their commercial success with various aspects of canopy management. Interested persons should contact Dr. Smart by email at richard@smartvit.com.au. Dr. Smart visits the U.S. frequently, and consulting appointments can be made by email. See also www.smartvit.com.au*

<<< Bodegas Torres helps alleviate climate change with a new CO_2 capture and fixation system. In its program to mitigate the effects of climate change, Bodegas Torres has begun to develop new technology designed to fix carbon dioxide sequestered during the fermentation processes and convert it into organic matter. This would reduce the CO_2 emissions in the atmosphere by wineries. This groundbreaking experiment in the winemaking industry was conducted in collaboration with the universities of Seville, Almeria and the CSIC (Spanish National Scientific Research Council).

Development of this new technology requires photosynthetic microorganisms (fresh water weed), which would receive CO_2 from the wine's fermentation processes if Bodegas Torres should adopt the system. During their growth, these microorganisms would use CO_2 as a source of carbon and convert it into organic carbon, thus transforming it into biomass, and other photosynthesis products released by cells, such as polysaccharides. Possible options for the use of this biomass include production of energy in the form of biofuel, or application as a fertilizer. In the 2008 wine production season, 10% of the CO_2 injected into the reactor was absorbed. In 2010, the results were 18%. Several years of further experimentation will be necessary to absorb enough CO_2 to reduce the winery's "carbon footprint."

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Lessons learned in California– INVASIVE INSECT SPECIES

BY David Headrick,
Horticulture & Crop Science Department,
California Polytechnic State University,San Luis Obispo, CA

Exotic species are those that originate outside of a particular boundary and do not occur within that boundary. The boundary is usually a human artifact – researchers, regulators, and those in the agriculture industry tend to use convenient boundaries such as geopolitical borders. Thus, we describe "exotic" as being from outside the U.S. or outside California.

The origin and range of a species is determined by its evolutionary history, not artificial lines on a map. A species that occurs in northern Mexico and parts of southern California is still exotic to other areas in California and beyond.

The range of a species is naturally dynamic and can expand or contract due to environmental conditions; of concern is when a species moves beyond its natural range into new areas.

Invasives are those exotic species that are in the process of entering and/or establishing in areas where they have previously been absent. Not all invasives are able to successfully establish. There are significant environmental hurdles for them to overcome when they find themselves in a new area.

Agriculture officials have been working for the last 100 years to keep exotic species out of California, and out of our country, but the borders are porous, and the pressure to exclude exotic species is great. A massive amount of plant material flows into this state from all quarters on a daily basis, and only a small fraction is inspected.

An often repeated statistic indicates that California accumulates one new arthropod (insect or mite) species every 60 days. That number was determined from state records (1955 to 1988). Since that time, the number has certainly increased. Although there is no strict analysis, simple observation indicates that new, agriculturally destructive pests are arriving at alarming rates.

Invasive "populations" are a major concern. Most of our past focus has been on invasive *species*. However, because distinct populations of a species experience vastly different environmental pressures depending on location, we can now envision the introduction of a uniquely selected population that may represent a significant threat to local production practices — and severely impact Integrated Pest Management.

For example, certain scale insect species are very widespread and occur in agricultural regions over much of the U.S. and Mexico. However, production practices differ, sometimes considerably, among different areas across this vast region.

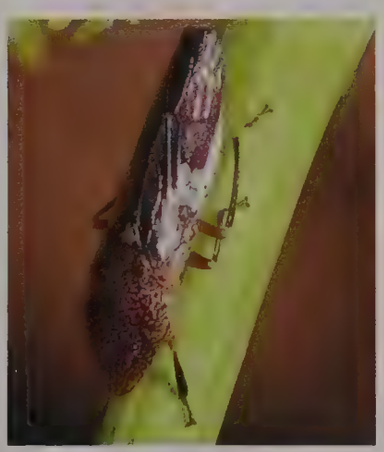
It is likely that accidental movement of these "regionally unique" populations could introduce individuals into our area that are highly resistant to certain management methods or chemical classes, thus compromising our ability to successfully manage them with our local, current practices. The trouble with this new concern is that we are geared to identify species. Identifying unique populations will take new tools and time to develop and implement them.

Invasive species are a major concern for agriculture because those species that successfully establish can become significant and highly disruptive pests. Any organism can purposefully or accidentally be moved into an area where it previously did not exist. Human activity is by far the single greatest contributor to unintentional movement of exotic species into new areas.

Some species enter a new environ-

European Grapevine Moth. Photo by Jack Clark.

Brown Marmorated Stinkbug (17 mm long). Photo courtesy of Virginia Tech.


Glassy-Winged Sharpshooter (11 mm long).

Spotted-Winged Drosophila (3.5 mm long). Photo courtesy of CA Department of Food & Agriculture.

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ment and find conditions favorable to establishment and growth. They take advantage of resources, lack of competitors and natural enemies (such as predators, parasitoids, and pathogens), and favorable environmental conditions.

Some species arrive, establish, and spread quickly. Others arrive and build their populations slowly. They may remain virtually unnoticed for years – even decades – until the processes of adaptation or other subtle changes occur that allow for population expansion, both geographically and numerically.

Glassy-winged sharpshooter (GWSS) is an example that is native to the Gulf Coast states with humid climates. The original reports of GWSS in California were from coastal locations. Following a 10-year lag, this species has spread to the hot, dry inland valleys of southern California and San Joaquin Valley and continues to expand its geographic range.

Growers are eminently affected by an invasive species. Economic impacts of a new invasive species are immediate and also can be long-lasting.

Invasive species can invoke quarantine restrictions, thus hampering the movement of product. Quarantine regulations can also require applications of pesticides — typically with most of the costs borne by the grower. For species targeted for eradication, those efforts can affect all levels of production practices and cause sudden changes in personnel needs.

Long-term management of invasive species that defy eradication usually means additional pesticide applications until other controls can be developed. Accurately measuring economic losses from invasive species is complicated and depends on the grower, commodity, the market, and biology of the invading organism. But that does not negate the fact that invasive species are a significant economic hardship for everyone.

Four invasive species help us understand the invasion process and our reaction to it: Glassy-winged sharpshooter, *Homalodisca vitripennis* (Germar); European grapevine moth, *Lobesia botrana* Denis

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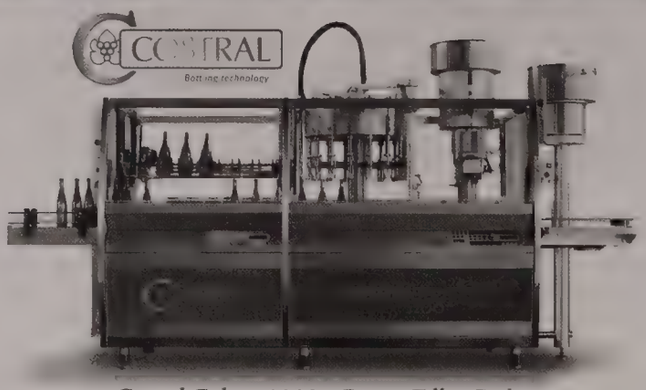

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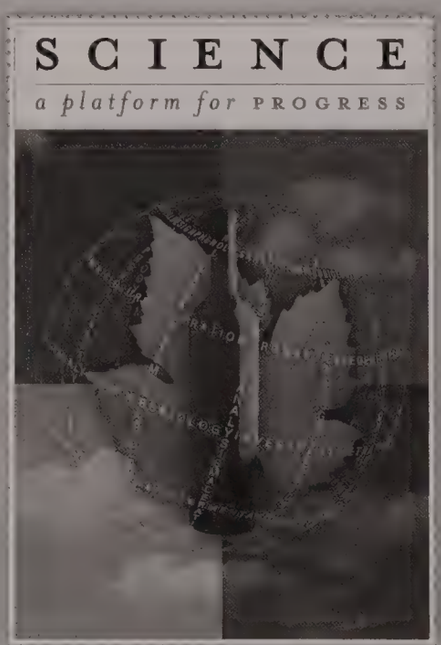

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& Schiffermüller; spotted winged Drosophila, *Drosophila suzukii* (Matsumura); and Brown marmorated stink bug, *Halyomorpha halys* Stål.

Glassy-winged sharpshooter (GWSS)

GWSS populations were first detected in Irvine and Ventura in the late 1980s. These isolated pockets remained virtually unnoticed until 1999/2000 when they began to rapidly expand their range. Soon GWSS was showing up everywhere in southern California and into the San Joaquin Valley.

It became apparent that Pierce's disease was being aggressively transmitted by GWSS and major vine losses ensued, especially in the Temecula area of southern California. The response has been well-documented and included governmental intervention, assessment-based research funding, detection trapping, phytosanitary certification, a Pierce's disease task force, and more. The overriding goals were to slow GWSS movement into new areas, develop ways to combat Pierce's disease, and develop appropriate tactics for area-wide GWSS management.

GWSS range/expansion has been slowed, but central and northern areas of the state remain highly vulnerable. A recent find of an adult GWSS in a residential area of the Central Coast has renewed awareness of the need to remain diligent.

LESSON ONE: **Insect invasions can take a long time.** GWSS is still in an invasion process in California, even after more than a decade. We cannot afford to let our guard down.

LESSON TWO: **Our detection program works.** Most uninfested counties in California practice two approaches to GWSS detection: 1) visual inspection of plant material arriving into the county, and 2) a trapping program, with weekly inspections of traps deployed in a grid pattern in susceptible areas.

The September 2010 find in San Luis Obispo County was due to the detection trapping program in a residential area. One adult was trapped and the identification verified. That,

in itself, does not trigger a quarantine by the state, but does require further inspections and delimiting the infestation.

Known GWSS host plants were inspected in most residential properties near the find and that turned up four additional adults and several egg masses. Finding these additional individuals then resulted in a quarantine of one square mile around the site. Seasonally appropriate control measures were enacted and an eradication program was developed and will be implemented in 2011.

The scorecard for GWSS eradication in California has been spotty. There are successes, such as Sacramento or the ongoing program in San Jose. The Fresno area has pulled back from eradication in the city limits and now targets the outlying areas.

The mixed record is mainly a result of the lack of effective eradication tools. These tools are based on some facet of the insect's biology that we can exploit and manipulate to its detriment.

Many successful insect eradication programs have had some type of pheromone or sterilized insect release tool that allowed for overwhelming wild populations and driving them to extinction. These types of tools are not available for GWSS, so every GWSS eradication program is going to have some uncertainty depending on location and circumstances.

European Grapevine Moth (EGVM)

This species was first reported in California in Napa County in October 2009; it also represented the first report of this species in North America. It is a significant pest for grape production causing extensive damage to fruit and flowers. This species is well known and widely distributed in Europe and has previously invaded other grape growing regions of the world such as North and West Africa, the Middle East, eastern Russia, Japan, and Chile.

EGVM is native to Italy. Its biology and management in most parts of Europe have been well documented. Many times an invasive species is new to science and very little is known about it. In California, we are fortunate that EGVM comes with a set of instructions and many of the tools needed for eradication and/or control are already available. Because this is a newly reported species in the U.S., it is subject to both state and federal regulations.

The California Department of Food & Agriculture and the U.S. Department of Agriculture are involved in developing eradication and quarantine regulations. In addition, federal support is available to fund these initiatives.

LESSON THREE: "Do not pack a pest." We all know the phrase. We all know

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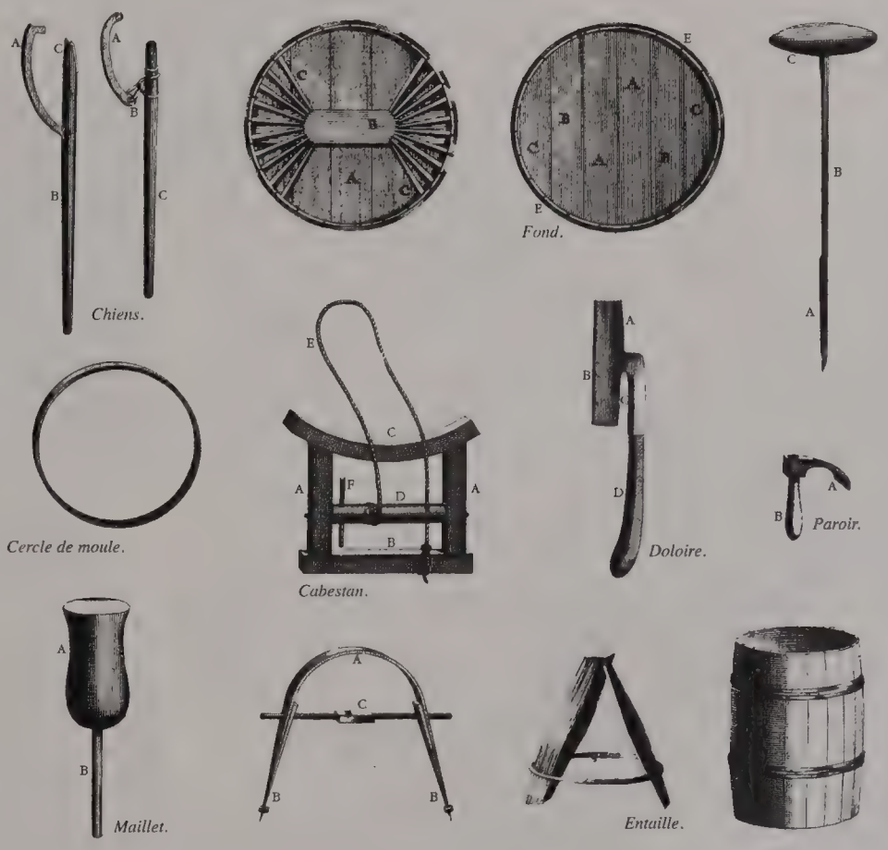

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the impacts of bringing in unwanted organisms on uninspected plant material. When unwanted organisms get in, establish and become pests – it negatively affects everyone because the environment is forever altered. The agriculture industry needs to work hard at continued education of the public sector on this issue – and of course, practice what we preach.

LESSON FOUR: **Implement eradication with care.** Many in the agriculture industry watched the events relating to the recent eradication attempts of light brown apple moth with mixed feelings. Light brown apple moth is a recent invader to the San Francisco Bay Area. In its native range, it is known to attack grapevines – among many other hosts – but feeds mainly on the leaves.

The state's eradication program began with aerial sprays of synthetic moth pheromone over residential areas in the Monterey Bay region. The resultant backlash from the residents pitted agriculture against urban groups in an unproductive way, and resulted in an embarrassment for the state's agriculture officials when they were forced to stop aerial applications. The resulting distrust will negatively affect all future eradication programs for many years to come.

The Napa/Sonoma region is ground zero for the eradication program for EGVM. Synthetic pheromone dispensers deployed in a mating disruption program are one of the tools for EGVM eradication. EGVM pheromones are being deployed in plastic twist tie dispensers rather than aerial applications.

The state is carefully conducting separate approaches for residential and agricultural areas. In agriculture areas, the tools of choice are pheromones for mating disruption and pesticides that target the eggs and larvae. In residential areas the tools of choice are different — fruit removal and applications of *Bacillus thuringiensis* (Bt), a natural product that targets young caterpillar larvae and does not affect other types of organisms.

The results of the first year are currently being assessed and this program will likely continue for some time. EGVM has three generations in Europe and determining the number of generations in all of California's varied climates is of great importance.

The success of eradication efforts will be based on having no moths caught in traps for up to five generations following the application of an eradication tactic; thus the number of EGVM generations per year will impact the duration of the eradication program. In other words, additional finds in traps results in waiting another five generations of no catches to have eradication declared successful.

Other parameters are discussed in the report of the Technical Working Group (TWG) for EGVM, which

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met in Napa, CA, November 8-10, 2010. [http://cenapa.ucdavis.edu/news_970/European_Grapevine_Moth_688/?newsitem=28882]

Spotted winged Drosophila (SWD)

This species is native to Asia and was discovered in northern California in June 2008. The first official damage to agriculture was reported in 2009. It is now considered established and no eradication efforts will be made. This fly is now a permanent part of our landscape. Why no eradication? It was discovered too late — small populations are easier to eradicate than widespread ones, and there are no effective tools useful to an eradication program for this particular species. SWD is now found throughout most of California and is in Oregon and Washington.

SWD attacks cherries, raspberries, strawberries, nectarines, plums, and blackberries in northern California, causing significant losses in these crops, but so far not in grapes. There was some early speculation that this fly might be of concern to grape growers, but some of that confusion was likely related to the scramble for a correct identification, and the use of incorrect common names.

LESSON FIVE: Correct identification is essential. SWD was fairly new and not much was known about it. There was some initial confusion regarding just exactly what it was, as it behaves in a manner that is inconsistent with other pests of its kind. There is another common name of "cherry vinegar fly," which is an appropriate one because it is not a true fruit fly. SWD is in the fly family Drosophilidae; sometimes they are referred to as fruit flies, but their official common name is vinegar fly.

True fruit flies are Tephritidae and include species such as Mediterranean fruit fly, olive fruit fly, and melon fly and they attack fresh fruit. Vinegar flies instead are typically attracted to rotting fruit, where they lay their eggs, and the larval feeding helps to break down and decompose the fruit tissues.

SWD, however, is atypical and lays its eggs in healthy fruit, leaving large oviposition wounds. As the larvae feed, the fruit begins to break down and rot. This rotting fruit then becomes attractive to our native vinegar flies in the usual manner. The resulting mess is a mixture of species that are very difficult to distinguish and identify.

Proper identification is always the first key step in any pest management program — especially with invasives. The challenge with invasive species is that frequently they are new and specialists may be challenged to secure an identification and getting that information out to the grower community in a short time-frame is difficult.

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Brown Marmorated Stink Bug (BMSB)

The latest invasive pest to get the attention of the grape industry is native to Asia and entered the U.S. on the East Coast in the late 1990s. It has spread to 29 different states east of the Rocky Mountains and now in California and Oregon. BMSB is not being considered for eradication because it became so widespread so quickly, and there is a lack of effective eradication tools for stink bugs.

This stink bug is known to attack more than 60 species of plants, grapevines included. They have piercing sucking mouthparts and feed on phloem and other fluids in a variety of plant tissues. They are known to feed on new and fully developed fruit, pods, stems, and leaves. Their saliva causes a toxic reaction, resulting in decaying lesions around the feeding site.

Stink bugs are well named because they emit a foul odor when disturbed as an anti-predator defense. BMSB also is known as a household annoyance because adults tend to congregate together beginning in the fall to spend the winter in warm structures such as houses. They are also reported to congregate in grape clusters around this time, and can impart their foul odor into the resulting wine. Research has begun on this issue in Canada, but in California we are still learning about this insect and what, if any, impacts it will have on grapes.

LESSON SIX: **Patience is a virtue.** We cannot derive long-term conclusions about an invasive species' biology based on what is observed early in its invasion process. Most invasive insect species have some similar characteristics when they are beginning their expansion in numbers and range into a new area.

One characteristic is that they can be found feeding on a much wider or significantly different array of plant species in the invaded area than they would in their native home. Some invasive species may be reported to feed on more than 100 different kinds of plants soon after their arrival — thus striking fear into most growers, perhaps unreasonably so. After a few years these invasive species tend to settle down to a more moderate number of preferred host plants.

A problem arises in this early, confusing phase of an invasion: Which com-

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modity is going to be most affected and thus, whose problem is it, and who is going to pay for the necessary research?

There is currently a wait-and-see mode with BMSB and its eventual effects on grape and wine production. The reality is that, in general, stink bug pest management is difficult. It is likely that growers of multiple commodities will need to work together on funding research for new ideas and do so soon.

Summary

Each new invasive species brings with it many unknown variables. The inability to predict how much damage they will cause, and how extensive and to what crops, is a cause of much of the anxiety surrounding an invasion. The problem of invasive species is not going to get any better. However, looking at these lessons may help temper a more reasoned reaction to future invasions.

Ultimately, everyone in the agriculture community is going to have to pull together to build appropriate resources and action plans. When it comes to invasive species and the damage they cause — we are all in this together. ■

Sins of Safety

Continued from page 33

insurance representatives, and AgSafe to provide the breadth of information necessary to cover all the standard's bases.

Safety Sin-6

Similar to Sin-5, Sin-6 concerns Standard 3441 – Operation of Agricultural Equipment. From October 2008 through September 2009, Cal/OSHA Enforcement issued 37 citations with a total of $133,600 in associated penalties. Another intricate standard, 3441 includes requirements for operating instructions and safe work practices, details on self-propelled equipment, safe place access, braking systems, equipment towing, engine exhaust systems, load access specifications, and a sunrise/sunset clause. As with other standards addressing the safe use of machines and equipment, the fines are steep given the serious dangers involved.

Agricultural business owners must understand that being penny-wise will ultimately prove to be pound-foolish – and if Cal/OSHA Enforcement catches up with you, the pennies saved by failing to develop a safe equipment program will be lost, and then some. It is critical that the time and dollars be invested up front, not only to avoid committing this sin, but more importantly, to keep your people safe and healthy.

Safety Sin-7

Sin-7 concerns Standard 342 – Reporting Work-Connected Fatalities and Serious Injuries, with 28 citations and a total of $73,600 in penalties. The components of this standard are relatively straightforward — immediate reporting parameters and methods should a fatality or serious injury occur, the qualifier for emergency services, and the specific information to report.

It is not surprising there are compliance issues with this standard, as it means calling the government and telling them something bad has happened. Few employers jump at the opportunity to involve government in their operations. That being the case, failing to contact Cal/OSHA ultimately puts you at a competitive disadvantage.

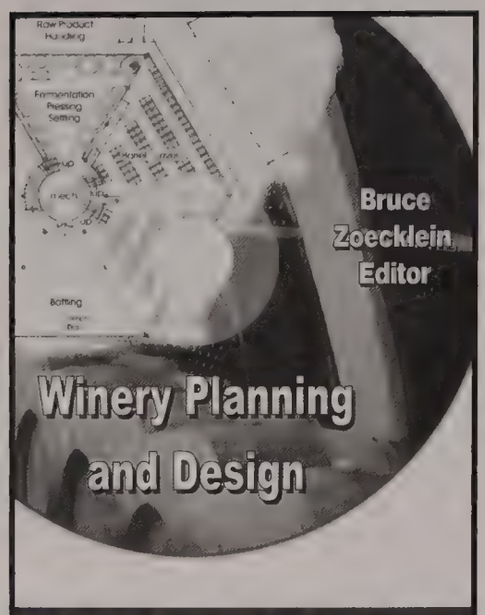
By being in compliance with the regulation you are not only abiding by the law — big plus there — but also you have greater control of the terrible situation that has taken place. It ensures you are at the heart of any and all communication and is the best solution to any unforeseeable issues that arise when a major injury or death takes place on the job.

In the end, aside from the fact that it is the right thing to do, it is the smartest business decision you can make as well.

Conclusion

These are the Seven Sins of Safety committed by California's agricultural industry. We now have the opportunity to repent and ultimately ensure the health and safety of our workforce. Make the effort today and your employees, along with your pocketbook, will thank you.

To learn more about AgSafe, visit www.agsafe.org or call 209-526-4400. ■



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FAR LEFT: First generation larva feeding in pre-bloom flower cluster.
LEFT: Second generation larva feeding inside a post-veraison berry. Note webbing and feeding holes in berry.

European Grapevine Moth, *Lobesia botrana*

Napa County Experience: Lessons Learned in 2010

BY **Monica L. Cooper, Lucia G. Varela, Rhonda J. Smith,**
University of California Cooperative Extension

Invasive species are an increasing threat to agricultural sustainability in our global economy. Detection of an invasive species triggers the development of regulatory programs, and a need for research and educational programs.

Regulatory programs encompass pest detection and containment efforts such as trapping, quarantines, and treatment recommendations. Such programs are coordinated locally by Agricultural Commissioners, statewide by the California Department of Food and Agriculture (CDFA), and nationally and internationally by the U.S. Department of Agriculture (USDA).

The regulatory program for the European grapevine moth (EGVM), *Lobesia botrana*, was developed in response to the pest's first detection in North America, in Napa County in September 2009.

A 2010 detection program deployed pheromone-baited delta traps in all vineyard regions of California, at densities of 16 to 25 traps per square mile. Male moths were found in traps in 10 California counties: Fresno, Mendocino, Merced, Monterey, Napa, San Joaquin, Santa Clara, Santa Cruz, Solano, and Sonoma.

To date, populations of this insect have not been found in North America outside California. Napa County populations were the largest: more than 100,000 males were trapped, compared with 128 males in all other counties combined (Table I).

During an aggressive treatment program, populations in Napa County decreased from 99,236 moths caught during the first flight to 1,278 and 279 in the second and third flights respectively.

A quarantine program is established if two or more moths or any other life stage is detected in a generation. Of the 10 counties, only eight counties have areas under quarantine. Single moth detections in Monterey and Santa Cruz counties did not trigger quarantines.

In four counties, very few moths were trapped and treatments were applied in 2010. If no moth is caught in these areas during the 2011 growing season — at a density of 100 traps per square mile and without mating disruption — these areas may qualify to be removed from quarantine. In the remaining counties, quarantine restrictions will remain in 2011.

Research and educational programs are addressing the need for reliable scientific information on pest identification, biology, and management. Researchers evaluate the effectiveness of tools such as traps, lures, and pesticides.

When EGVM was detected, growers, researchers, and regulatory agencies were confronted with many unknowns, including a lack of experience with the life cycle under California conditions, and the role that alternate hosts have on development and mechanisms of pest spread. There was a need to develop pest management strategies aimed at eradication.

This is very unlike the situation in Europe, where the objective is to obtain clean fruit at harvest, not to completely reduce populations. Studies were needed to identify the most effective and least disruptive insecticide application at the best timing.

In particular, we need to avoid exacerbating natural enemies of grape mealybug. This could create a more severe problem, such as the increased spread of viruses causing grapevine leafroll disease. Finally, the highest risk pathways in which these insects

Pheromone dispenser registered for use in mating disruption program.

TABLE I: Males trapped by County and by Flight* (2010)

	Napa	Sonoma	Solano	Mendocino	Fresno	Merced	Monterey	San Joaquin	Santa Cruz	Santa Clara
1ST Flight	99,236	24	8	35	6	4	1	0	0	0
2ND Flight	1,278	30	3	0	5	0	0	0	0	0
3RD Flight	279	5	0	1	0	0	0	2	1	3
Total Males Trapped (2010)	100,793	59	11	36	11	4	1	2	1	3
Total traps serviced at peak trapping	8,068	4,965	1,514	1,594	8,648	860	1,733	3,522	449	596

Traps catches from CDFA Statewide trapping program of European grapevine moth, 2010.
*By flight is estimated because traps were serviced at minimum of 14 day intervals.

spread were investigated, to help regulatory agencies develop effective containment programs.

What was learned about EGVM in Napa County vineyards in 2010?

European grapevine moth (EGVM) completes three generations per year in the majority of the grape growing regions of California. Models predict the possibility of a partial fourth generation in the Central San Joaquin Valley, although populations in that region are too low to be able to verify this in the field.

Eggs are laid by females on or near flowers or fruit. Larvae develop through five stages before pupating. Adults emerge from pupae. One generation is defined as the development from egg to adult. The spring (first) generation develops from bud break through berry set. The summer (second) generation develops from berry set through post-veraison. The late summer/fall (third) generation develops from post-veraison through post-harvest.

This insect spends the winter as pupae under the bark, in a resting state of reduced metabolism (diapause) to survive cold temperatures. We are currently verifying a degree-day model that will be useful in predicting the occurrence of events in the EGVM life cycle.

The main host of consequence identified so far in California is grape *(Vitis vinifera).* Moth larvae feed preferentially on grape flowers and fruit. Untreated populations can cause extensive damage to clusters, mainly as a result of secondary fungal infections.

Olive flowers were a minor host in Napa County during the first generation of 2010. The number of eggs and larvae found on olive flowers was 0.3 to 3.0% of what was found in vineyards during regular sampling. Olive fruit did not host either the second or third generations.

Studies of plants in riparian areas have thus far not identified any riparian host of EGVM in Napa County.

Another host of consequence in the Mediterranean region is *Daphne gnidium.* This host has not been found in North America. Host studies will continue in Napa County in the coming years. In the meantime, management programs will focus on vineyards. Olive flowers may be treated when first generation larvae are developing.

Pheromone-baited traps are an effective monitoring tool in vineyards without mating disruption. There are two types of lure available: 1) a rubber septum impregnated with the pheromone, and 2) a square patch containing a membrane with the pheromone.

Traps baited with rubber septa lures caught significantly more moths for three weeks in the spring when temperatures were at the lowest of the season. Membrane lures caught on average 20% more in the warmer months.

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Pheromone-baited delta traps should be placed in a vineyard as bud break approaches and monitored on a weekly basis until harvest. Males do not fly great distances. At least one trap should be deployed for every 10 acres, or one trap per block in parcels smaller than 10 acres. Traps should be oriented such that the base of the trap sits at the top of the grape canopy; traps should be moved up the trellis as the canopy grows.

Mating disruption can be a very effective management tool. Mating disruption technology deploys a synthetic version of the female sex pheromone. It is an organically-acceptable pest management method.

The dispenser registered for use is a twin tube hung in the vineyard (200 per acre). The plumes of synthetic pheromone that are slowly released by the dispensers make it difficult for males to locate females for mating. Delays in mating affect fecundity; ageing females produce fewer eggs.

Unlike insecticides, which kill the same proportion of a population regardless of population size, mating disruption becomes more effective as insect populations get smaller. It can therefore be a very effective tool for growers managing dwindling insect populations. It can be especially useful during the third generation, since the material does not need to make contact with a life stage to be effective. Mating disruption dispensers should be deployed at or just after bud break.

Insecticides can be used to manage populations during the first and second generations. Available insecticides are active against eggs and larvae (ovicide/larvicide), or strictly against larvae (larvicide). Organic growers have the option of using *Bacillus thuringiensis* (various products) or spinosad (Entrust®).

It is critical to rotate between different modes of action to avoid or delay development of resistance to these insecticides. Many of the insecticides are reported to be minimally toxic to beneficial insects, although unwarranted applications should be avoided whenever possible.

Conventional growers may apply first generation treatments (1) at or shortly after peak flight; or (2) at egg hatch. Insecticides applied at peak flight should have an ovicide/larvicide activity. Insecticides applied at egg hatch may have ovicide/larvicide or strictly larvicide activity.

If the conventional insecticide is applied at egg hatch and the product residual is sufficient, then only one application should be necessary during the first generation. Organic growers should begin applying insecticides at egg hatch. Depending on the product residual and the length of the flight, two to four applications may be needed for the first generation.

It is important to monitor the flower cluster after an application, especially if a short residue insecticide

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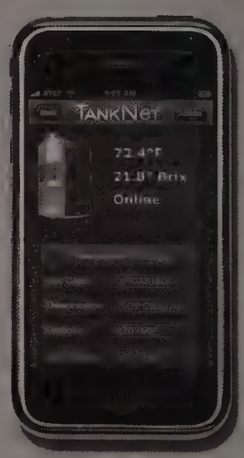

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was applied. Search for webbed nests containing flower parts with abscised flower caps. Tease apart the nests and look for the worm, bites on individual flowers, webbing, and/or excrement.

Conventional growers treating the second generation may make one application of an ovicide/larvicide or a larvicide. Optimal timing for an ovicide/larvicide application is three to five days after the first moth of the second generation is detected. Optimal timing for a larvicide application is egg hatch (roughly 10 to 14 days after the first moth is detected).

Organic growers will also begin applications at egg hatch, and may require two applications to cover the length of the generation. Larvae of the third generation are difficult to treat with insecticides because of their habit of burrowing into berries immediately upon emergence from the egg.

Summary

Napa County management programs for EGVM were very successful in 2010. There were no reported crop losses to EGVM feeding damage. Available management tools were very effective, specific, and minimally toxic to non-target arthropods.

Growers took initiative and responsibility to educate themselves and their employees on the biology of the pest, and made appropriately-timed applications of insecticides and mating disruption. Organic growers were able to maintain their certification while also controlling pest populations. Quarantine restrictions were respected and compliance was high.

Future research efforts will focus on validation of predictive models for California, and continued monitoring of potential hosts in riparian and landscape vegetation.

Alternatives to pheromone attractants to monitor vineyards under mating disruption will be explored. Different formulations and timing of organic insecticides to improve efficacy will be investigated. Finally, the fate of larvae during the winemaking process will be evaluated. ■

For more information visit:
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BOOK EXCERPT

In search of uniformity; why grape quality varies

BY Markus Keller

The *Science of Grapevines* is a new 400-page book that comprehensively explores the physiology of the grapevine as it occurs around the world. It focuses on the whole plant rather than at the cellular and organ levels, providing an understanding of whole-plant function. Comprehensive coverage of the role of water relations and temperature prepares the reader for changing climate impacts. Worldwide information on grapes and grape-related industries provides important insights into implications of differences – and similarities.

The truly unique approach of this book is the scientifically-grounded exploration, often applying discoveries in other plant species, of the main physiological processes underlying grapevine form and function, their interactions, developmental and environmental control, and their implications for practical vineyard management.

The following is an excerpt from Chapter 6, Developmental Physiology.

6.3. Sources of variation in fruit composition

Uniform fruit composition is often described as a critical factor for premium wine making and is equally desirable for the production of grape juice, table grapes, and raisins. It could be argued, however, that less uniform fruit may sometimes result in more complex wine, and this might be one of the rationales behind blending wines from different vineyard sources. In many European wine regions, such blending was traditionally done in the field, where a range of clones or even cultivars were interplanted, sometimes systematically and sometimes randomly.

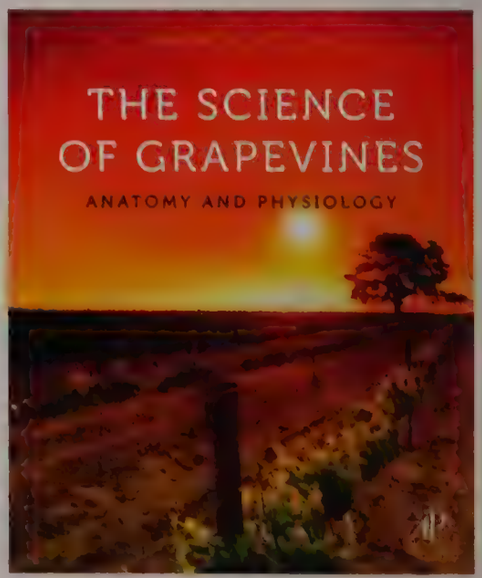
Whereas traits related to color, astringency, acidity, and flavor are key quality attributes of wine grapes, table grape quality depends more on sugar:acid ratios, texture for crunchiness or crispyness, and visual appearance, including color,[24] although Muscat flavor is often also sought after. Seedlessness is important in some table grape markets and is usually desirable for raisin grapes, for which high sugar content is much more important than it is for table grapes.

Fruit composition changes over time during the berry ripening period as part of the grapevine's developmental program and is therefore under genetic control. In addition, like phenology and yield formation, the extent of these changes may also be modulated by environmental factors and by the interaction of these factors with the genotype of the vine. It is often difficult to separate the influence of one of these factors from that of another.

For example, solar radiation affects both incident light and tissue temperature. An increase in water supply leads to an increase in shoot growth, which can decrease the proportion of exposed leaves, which, in turn, alters both light quantity and light quality, and may also lead to changes in canopy microclimate (Chapter 5.2).

Fruit maturity varies between vineyards, between vines in the vineyard, between clusters on a vine, and between berries on a cluster.

Furthermore, the sugar concentration is higher and the malate concentration lower in berries that have fewer seeds, apparently because veraison occurs earlier in such berries.[7,28] Thus, even within a grape cluster, there is often a natural variation of sugar concentration in the range of 5° to 7° Brix that results from asynchronous development of individual berries.[6] Due to such asynchronous development, neither time nor thermal time after bloom adequately reflects the developmental stage and maturity



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THE SCIENCE OF GRAPEVINES: ANATOMY AND PHYSIOLOGY *(ISBN #9780123748812) was published February 2010 by Academic Press, Elsevier (elsevierdirect.com).*

of individual berries in a sample from the entire population of berries on a vine, let alone in a vineyard.

Any factor that influences vine growth and metabolism directly or indirectly impacts fruit composition, and this leads to large variation among growing seasons in terms of fruit quality. Wine grape production is especially sensitive to climate variability. This sensitivity is the source of considerable variation in vintage quality, which, in turn, forms one of the bases for the existence of an entire "industry" of wine judges, consumer magazines, and related services.

The majority of the fluctuations in fruit composition are caused by climate variability. In fact, weather differences among years, in addition to vineyard location, are by far the strongest determinants of fruit composition.[9] Such climatic differences often trump seasonal differences in soil moisture (except at the far low and high ends of the moisture spectrum) in both dry-farmed and irrigated vineyards.[19,25,34]

For instance, seasonal variation accounts for an almost two-fold range in sugar concentration, a two- to three-fold variation in acid and anthocyanin content, and at least ten-fold range in aroma components.[2,3,8,35,42] The differences in anthocyanin profiles – that is the relative proportion of individual pigments for a given cultivar – varies more among years than from veraison to harvest in the same year.[27] These differences hold true even at the genetic level: differences in gene expression in grape berries between growing seasons can be greater than those between pre- and post-veraison berries within a season.[26]

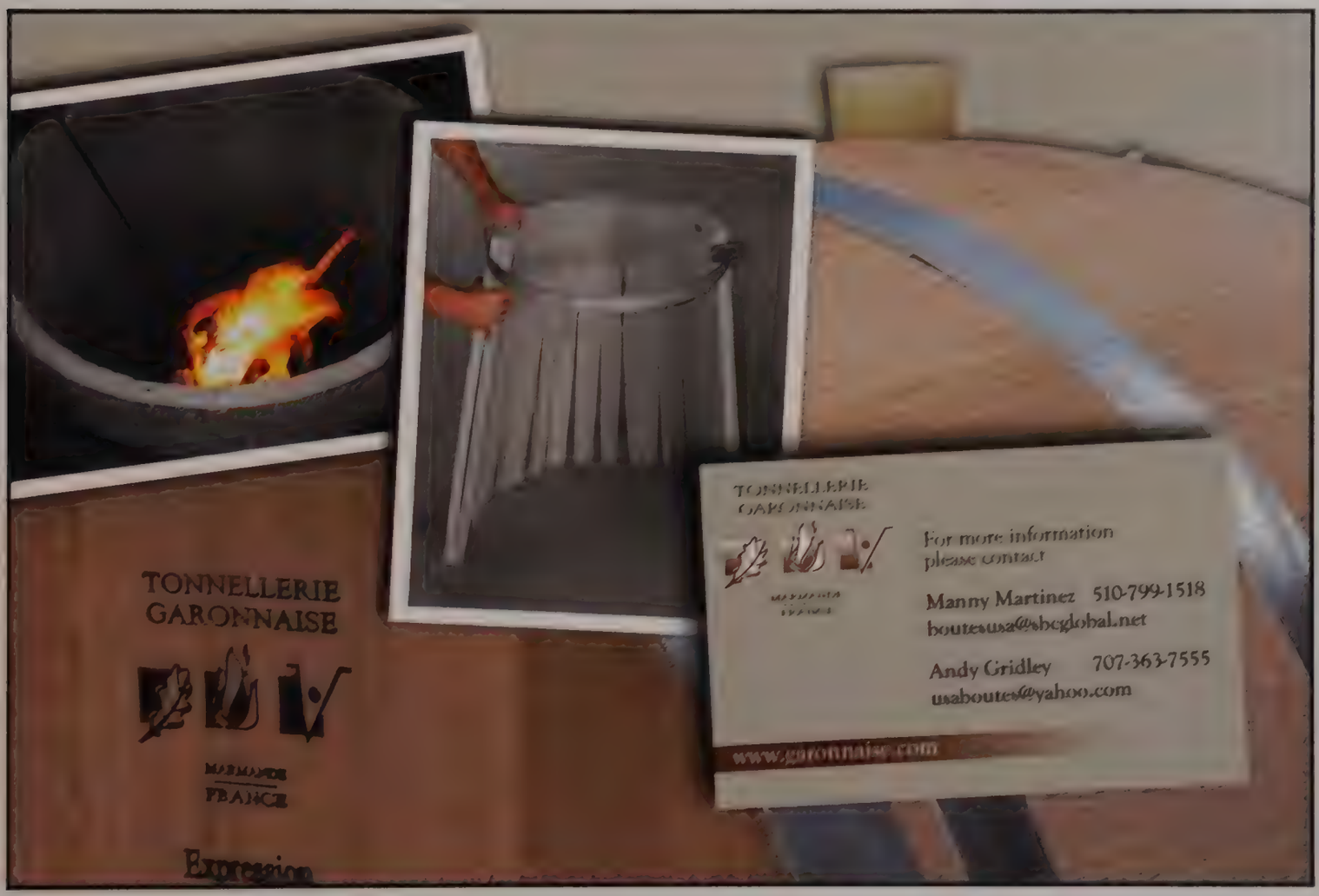
Cultural practices can, at best, be used to fine-tune what nature imposes in any given season. The same applies to clones of a cultivar and the rootstock used as grafting partner: season and site still vastly outweigh the influence of these on fruit composition, although rootstocks may lead to considerable differences in yield.[33] Even grapes harvested at identical concentrations of soluble solids in different years can have very different amounts of anthocyanins and aroma-active compounds.

For a specific genotype, variation in grape composition occurs within one vine, between vines, between vineyards, and between growing seasons due to, among others (e.g. some effects of pathogen infection are discussed in Chapter 7.5), the factors discussed in the following sections (also see Jackson, 2008).

6.3.1. Fruit Maturity

Contrary to widespread misunderstanding, especially among winemakers, grapes are physiologically mature when the seeds attain their ability to germinate (i.e. immediately after veraison, see Chapter 2.3), not at some arbitrarily defined point thereafter. Nevertheless, subsequent alterations in fruit composition may be beneficial for the seeds and hence for the species, since they help attract seed dispersers.

As argued in Chapter 2.3, the accu-



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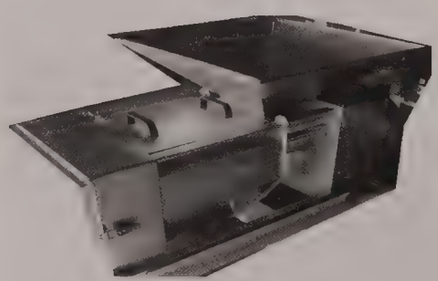

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mulation of color and aroma volatiles serves as "advertisement" to signal to potential seed vectors the availability of food material of high nutritional and health value. In fact, the majority of pigments and volatiles are manufactured from nutritionally valuable components such as sugars, amino and fatty acids, and carotenoids, and thus serve as positive nutritional signals.[13]

Many of the associated changes during grape ripening were discussed previously for individual compounds or specific groups of compounds. In addition to the well-known increase in the concentration of sugars, amino acids, and phenolic compounds (especially anthocyanins in red grapes) and the decrease in acidity (with a corresponding rise in pH), flavor and aroma components also undergo changes as grapes ripen.

For instance, methoxypyrazines decline most rapidly during the early ripening phase,[22,31] while norisoprenoids and most other terpenes, or their glycosylated aroma precursors, appear to continue to increase even at very advanced stages of maturity (above 30° Brix).[11,14] Such increases during extended ripening or "hang time" of the grapes form the basis for delaying harvest to maximize terpenoid-based aroma compounds.[39] While the concentration of some volatile phenols (guaiacol) increases strongly during maturation, perhaps due to conversion of hydroxycinnamic acids, others (eugenol) seem to remain constant or even decrease.[11]

The precursors of some aroma-active esters also appear to decrease over time (resulting in wines with less "fruity" aroma), but the majority show no consistent trend. It is not clear which changes late in the growing season are indeed due to the continued production or modification of these quality-relevant compounds in the grape berries or simply brought about by the slow dehydration of the berries (concentration effect, weather permitting).

Moreover, physical and chemical changes in fruit composition also lead to changes in the number and composition of microorganisms that call the fruit home. As the sugar concentration and the pH increase, both the number and the diversity of this microflora increase. Yet the consequences of these population dynamics for grape juice and wine composition are not well understood and little appreciated.

Clearly, some of the alterations in fruit composition with increasing grape maturity are desirable (e.g. more sugar, less acid and bitter tannin, more "good" and less "bad" flavors). Whereas others are not (e.g. even more sugar, high pH, and less "good" and more "bad" flavors). Moreover, the desired level of fruit maturity depends on the intended use of the grapes.

Taking soluble solids as a simple measure of maturity, table and juice grapes may be harvested when they have accumulated just 16° to 18° Brix, which is immediately after they have fully turned color. Grapes destined for sparkling wine production are considered optimally ripe at approximately 18° to 20° Brix.

While the typical harvest "window" for many white wine grapes ranges from 20° to 24° Brix, red wine grapes are often left on the vines well beyond the physiological sugar maximum of 24° to 25° Brix – weather permitting. The factors described in the following sections exert much of their influence on fruit composition by accelerating or retarding grape ripening and hence maturity.

6.3.6. Crop Load

The classical view of the relationship between grape yield and quality is that of a linear decrease in quality with increasing yield per vine.[7] However, this is an oversimplification, and there are many instances in which the quantity and the quality of the crop are not related,[16,19,20] or are increased simultaneously.[5]

In a study conducted over four years with 80 individual Riesling vines, the between-vine variation in yield was about five-fold higher than that in either juice soluble solids or titratable acidity.[12] A meta-analysis of Riesling clonal trials conducted at 16 locations over 37 years found that yield and soluble solids both increased over time, whereas titratable acidity decreased.[23] Much of the variation in yield was attributed to site effects, whereas the change in fruit composition was clearly linked to the rise in average temperature over the same period.

Although yields and mean tempera-

tures continued to vary considerably from year to year, the variation in fruit composition declined over time, indicating that composition was not greatly affected by yield and that improved vineyard management contributed to the change in fruit composition.

It is not so much the crop size or yield per se that is important but, rather, the crop load, which is a reflection of a vine's sink:source ratio,[1,18,32] (also see Chapter 6.1). For instance, an increase in vine spacing is typically associated with a higher yield per vine, but vine size, and thus leaf area per vine, also increases, so fruit composition and wine quality may be completely unaffected.[41]

Conversely, when a higher planting density, which is associated with lower yield per vine, leads to competition among shoots for sunlight, the fruit may have higher titratable acidity while, at the same time, the juice pH is also higher,[10] possibly due to recirculation of potassium from shaded, aging leaves to the clusters.

As a general rule, a leaf area of 10 to 15 cm^2 is required to fully ripen one gram of fruit, and this normally results in a yield:pruning weight ratio of approximately 5 to 10.[21] If the crop load is lower than this (i.e. undercropping or sink limitation), then the vine will invest comparatively more resources in vegetative growth, which can, in extreme cases, reduce fruit quality via the follow-on effects of a dense canopy. Moreover, berry size may increase to compensate for the low number of berries relative to leaf area.[20,32]

Conversely, if there is insufficient leaf area to ripen the fruit (i.e. high crop load, overcropping, or source limitation), then the rate of ripening will decline. This is why vines of medium vigor often produce both higher yield and better-quality fruit than vines at either end of the vigor spectrum. Such vines are said to be balanced – that is, the crop size matches their vegetative growth and leaf area development.

Furthermore, the leaf area required to ripen one gram of fruit also depends on the trellis and training system; it appears to be considerably higher in a typical vertically shoot-positioned canopy than in vines that are sprawl-trained or trained to divided canopies.

Overcropping ordinarily delays fruit maturation and therefore decreases grape sugar and color if harvest cannot be delayed.[1,36,38,40] However, the effect of crop load on berry composition depends on how a difference in crop load is achieved. An outbreak of pests or diseases, or a hail storm, can reduce photosynthetically-active leaf area after the yield potential has been established, which results in reduced sugar accumulation.

If an increase in yield is accompanied by deterioration in the canopy microclimate, then the changes in fruit and wine composition are negative.[29] In other words, so-called overcropping effects are often actually shade effects caused by poor pruning practices or other vineyard management errors.

For example, if pruning is too light (too many buds left), then there may be too many shoots, which leads to a dense canopy. Alternatively, if pruning is too severe (too few buds left), then the few remaining shoots may grow too vigorously and produce too many laterals, which leads to shade in the fruiting zone. In contrast, where an increase in yield is accompanied by an improvement in the canopy microclimate, berry composition may also be improved.

For example, the concentration of undesirable methoxypyrazines in grapes grown on high-yielding minimally pruned vines can be dramatically reduced compared with lower-yielding spur-pruned vines. Indeed, when yields are increased by decreasing the pruning level (leaving more buds), the resulting wine is often fruitier and less vegetative, perhaps due to the reduced shoot vigor (also see Chapter 6.1).[4,5] If, on the other hand, yields are stimulated by abundant water supply, the result is usually the opposite.

Therefore, balancing shoot growth and fruit production is an important viticultural goal. For an individual vine, the crop-load/fruit-quality relationship generally follows an optimum curve with increasing quality as crop load is increased from a very low level, followed by a plateau, and finally a reduction in quality when crop load is further increased. Under changing external conditions (including cultural practices), this curve can be shifted upward or downward.

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Rather than setting a specific, inflexible target yield, economically-minded vineyard managers aim to achieve the highest possible yield without compromising quality. Moreover, where weather conditions permit, delayed ripening can sometimes be compensated by delayed harvest.

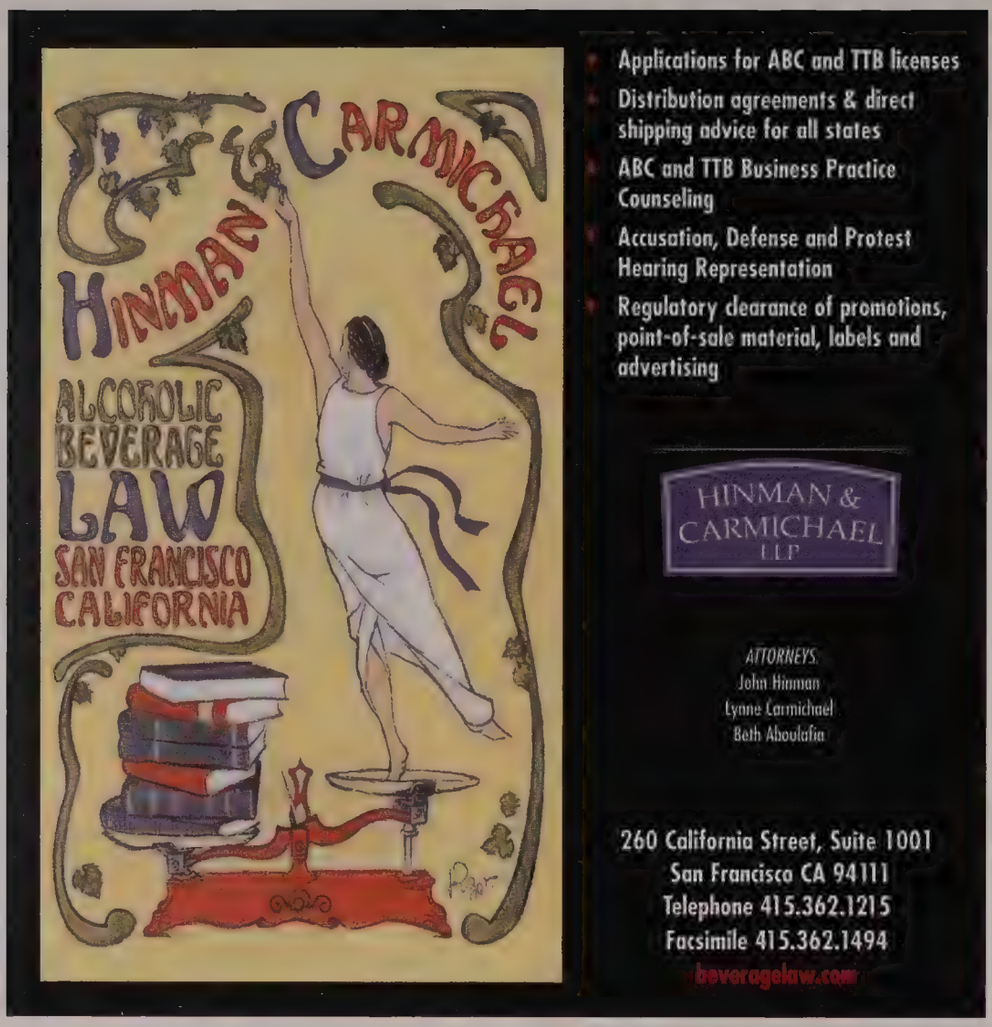
On overcropped vines, cluster thinning is typically employed to reduce the crop load and enhance ripening. This can be especially beneficial in cultivars that are prone to overcropping due to their large clusters, such as Syrah, Mourvèdre, Grenache, or Zinfandel.

One form of cluster thinning is cutting away the distal one-third or half of the flower clusters during bloom, which not only decreases yield but also often leads to less compact clusters due to the compensatory stretching of the rachis. It is possible that the advanced maturity observed following such early thinning may be attributed less to the smaller crop than to the tendency for berries in the proximal portion of a cluster to ripen more rapidly than those in the distal portion.[37] In table grapes, where large berries are desirable, cluster thinning is sometimes supplemented by berry thinning.

The size of individual berries is often more important than the crop level or even crop load in determining fruit composition. For instance, large increases in berry size after veraison may be coupled with concomitant increases in berry sugar and K due to phloem import.[30] The concentration of K in the berries decreases as the crop load increases.[15]

However, because tartrate synthesis inside the berry ceases at veraison, an increase in berry size can lead to a substantial decrease in tartrate due to a "dilution effect." Of course, more K and less tartrate in the berries will result in a corresponding increase in juice and wine pH. In addition, larger berries have a relatively smaller skin:pulp ratio, which has implications for red wine composition and quality due to the importance of the extraction of skin-derived compounds (mainly anthocyanins, tannins, and flavonols) during fermentation. In contrast to grapes used for red winemaking, large size and crispness are important quality traits of table grapes. ■

References for this excerpt can be found at practicalwinery.com.



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WINE MARKET SEGMENTATION BASED ON TASTE SENSITIVITY

BY Virginia Utermohlen MD, Tim Hanni MW

Somewhere in the neighborhood of 80,000 different wines are available in the United States. Wineries face a huge challenge of determining how to make their wines stand out in the crowd. For large-scale producers, the challenge is how to reach the most people with the right product, pricing, and messaging. For small, specialty producers, the challenge is how to identify and sell to the right consumers in their market niche.

In order to meet these challenges, we offer an approach to wine market segmentation that integrates the physiological and psychological dimensions affecting consumer preferences, behaviors, and values, and ultimately, wine choices. This approach is the equivalent of defining and targeting consumer "phenotype" segments.

The *Encyclopedia Britannica* defines a phenotype as: "all the observable characteristics of an organism, such as shape, size, color, and behavior, that result from the interaction of its genotype (total genetic makeup) with the environment. The common type of a group of physically similar organisms is sometimes also known as the phenotype."

Wine consumer phenotype segments are created by grouping people that use a combination of physiological taste sensitivity elements and the inevitable changes in wine preferences that occur from interactions with other wine drinkers, social influences, aesthetics, habituation, and fashion.

This approach helps us understand the key elements that define each phenotype segment and ultimately drive consumer choice. This in turn provides the ability to narrow down and target populations of wine consumers with the right products, language, and messages.

"After 50 years in the wine business, my life was changed when I experienced the research of Tim Hanni and Dr. Utermohlen and learned about my Sensitivity Quotient. Boy, do I feel better about my own wine preferences ... I always assumed there was something wrong with me because I liked sweet wines!"
– Harvey Posert, author of *Spinning the Bottle*, consultant, former Director of Communications / Public Relations for Robert Mondavi Winery, and the Wine Institute.

Why physiology?

The answer to this question is that our sensory physiology dictates how sensitive we are to different tastes and flavors. Simply put, some people have more taste buds than other people, and some people get a stronger message from wine — of acidity or alcohol, for example — than others.

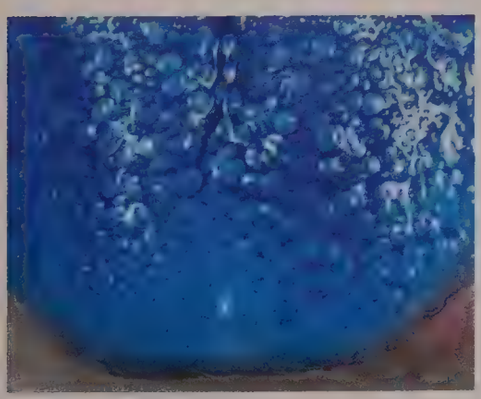
The differences can be dramatic. Compare the photos of two tongues. The left tongue has a carpet of taste papillae (the large bumps that carry the taste buds) that extends well beyond the tip. By contrast, the tongue on the right has more of a scattering of the larger bumps as you look toward the back of the tongue. (Note that the tongues have been stained with blue food coloring so that the papillae stand out — for the tongue on the right, the dye has pooled around the edges of the taste papillae so they appear as rings.)

It is easy to imagine that the person with more papillae will get stronger taste messages than the person with fewer papillae, and, typically, this is the case. The total number of taste buds in the tongue, according to some estimates, range from fewer than 500 for some people to over 11,000 for others.

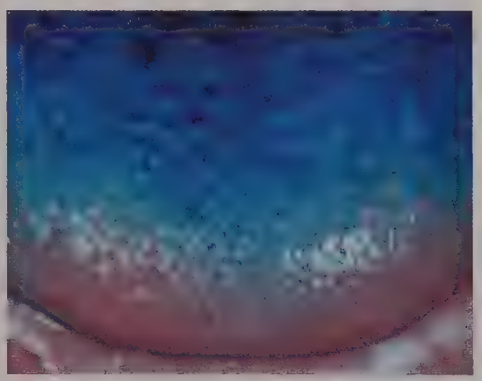
Having more taste buds does not equate to a "superior palate" or better ability to taste wine. It does mean that people with different sensory physiology may experiences sensations differently, and research shows that many people sense compounds that other people are incapable of sensing at all. This information helps ensure that the right wine style is targeted to the right phenotype segment.

Of course, taste sensations must go to the brain to be experienced, processed, and interpreted; this is where physiology meets psychology. Stronger sensations reaching the brain make for stronger impressions — either good or bad. Our personal values, culture, life experiences, habituation to sensations, and aesthetics all come into play in assessing and defining what a sensation represents.

If more sensations go to the brain (in other words, if you are more sensitive), higher alcohol levels often give a strong, unpleasant, burning sensation. If you are less sensitive, alcohol can give a sweet sensation with a pleasant, gentle burn or no burn at all. Sweetness in a wine can mask the burning sensation that highly sensitive people experience with high alcohol levels — a person who finds a dry red wine with 15% alcohol very painful may enjoy a cream sherry with 17% alcohol.



Hypersensitive tongue.



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Primary Wine Flavor Categories

We have distinguished four primary flavor categories of wine that map to the flavor preferences and language the four phenotype segments are predisposed to favor. Many mitigating psychological factors are involved that play an equally important role in the development of our ever-changing personal preferences. The more natural or unbiased a person's wine preferences are, the more useful this categorization of wine styles becomes for looking at your products against market opportunities.

Applying these categories means grouping wines by words that are meaningful to consumers in the next generation of progressive wine lists in restaurants. Flavor-based wine sections provide a safety zone for consumers who do not relate to the confusing, metaphorical descriptive terms favored by the industry and more aspirational wine consumers.

Sweet (Sweet phenotype)

This is the most easily defined flavor category of all — the wines are sweet. Sweet phenotypes indicate the second and third most desirable descriptors are smooth and fruity. White Zinfandel is the benchmark, and Moscato is the wine that is showing explosive growth from a small base. Sangria, Lambrusco, and sweet red wines all fit into this category, and there is a lot of room to offer higher priced wine with marketing focused on developing cachet and appropriateness at the table.

Our research confirms that consumers who prefer sweet wines unabashedly declare that they want wine that is truly sweet, not just off-dry or slightly sweet, and the reticence of the wine industry to employ the word sweet as a descriptor to this segment is unfounded. This flavor category is for wines that range from about 15 grams of residual sugar to a "sweet spot" of 30 g/l and then up to 80 g/l or even more. Alcohol levels should be kept very low; typically in the 10% alcohol range or less.

Sweet phenotypes experience bitter elements, reductive aromatic characteristics, and high acidity at exaggerated intensities. SO_2 additions must be closely kept in check to avoid offensive odors for the ultra-sensitive Sweet phenotype.

The wine industry's misguided efforts to "move up" these consumers to dry wine, results in their migration to cocktails or other sweet beverages, and adds to the disenfranchisement that we have erroneously created for them. They also want to enjoy these wines with steak, chicken, and fish, so be careful with wine and food pairings that virtually eliminate wines from consideration for everyday enjoyment with meals Sweet phenotypes prepare and enjoy.

Delicate (Hypersensitive phenotype)

Pinot Grigio made in a low intensity, low alcohol, and traditional manner fits this category. Attempts to make barrel aged, high alcohol, and more "serious" styles of Pinot Grigio may steal a few Chardonnay drinkers, but this crowd wants their wine light, smooth, and fruity. Riesling is as a great fit for this segment, but confusion about sweetness levels and aromatics tend to restrict its potential growth.

Delicate wines are mostly dry or may be up to about

15 g/l of residual sugar. The popularity of wines such as Chardonnay and many Sauvignon Blancs with traces of residual sugar is best explained from the viewpoint of the Hypersensitive taster. This is by far the group that "talks dry and drinks sweet," but at a level of sweetness significantly lower than that preferred by the clearly defined Sweet wine consumers.

Consumers inclined to prefer Delicate wines also favorably respond to the word "fragrant." Care must be taken in managing the aromatics for this highly sensitive segment so that the aromas do not become too intense — like being stuck in an elevator with someone doused in cologne! Again, bitter elements, reductive aromatic characteristics, and high acidity are experienced at exaggerated intensities, and SO_2 additions must be closely kept in check in Delicate wines.

Smooth (Sensitive phenotype)

Smooth is the most often cited positive descriptor across all of the phenotype segments in our research, and this aligns with results from many other studies. The word "Smooth" as a flavor category resonates with the Sensitive phenotype, and is inherently associated with a wine that is dry, full-bodied, richly fruity, and complex. This category runs the widest gamut of regions and grape varieties, including Alsatian whites, Chardonnay, richer-style Pinot Noir, Rhône wines, and all sorts of white and red blends.

Smooth wines can be well concentrated and higher in alcohol, and to demonstrate the benefit of residual sugar in suppressing bitterness, they can have up to and just over 10 g/l of residual sugar. Wines in this category are usually made with modern techniques. Whites benefit from the smoothness associated with malolactic fermentation, and reds need to be deeply extracted with minimum harsh bitter or astringent characteristics.

Intense (Tolerant phenotype)

Defining Intense as a flavor category is relatively simple: more color (almost invariably red), more flavor, more alcohol, more tannin, and more oak. The frustrating thing for many in the industry is the dominance of this style of wine and the accompanying 100-point system that is custom-built for assessing this style, which resonates with the psyche of the Tolerant phenotypes who love Intense wines.

There is an interesting opportunity unfolding as we deepen our focus on this group – the reverse of the wine and food dilemma that Sweet wine consumers experience (the common message that sweet wine does not pair with mainstream foods).

People who truly love Intense wines often want these wines from beginning to end during their meal. This means ensuring that people drinking Intense wines feel completely at ease ordering the wine they love with seafood, chicken, vegetables, or anything else they fancy. The truly Tolerant phenotype is not subject to the metallic, bitter clash more sensitive people experience, so let's remove the limitations!

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Bitterness and acidity in a solution also seems to play an important role in defining the intensity at which alcohol is perceived, and this is an area of exploration in our research. Many of the arguments among wine critics and professionals over wine quality and appropriateness of alcohol levels can be explained using the insights of our phenotype segmentation.

Using these insights into physiology and psychology — coupled with the results of consumer surveys involving thousands of people both in the U.S. and abroad — we have segmented wine consumers into four basic phenotype groups: Sweet, Hypersensitive, Sensitive, and Tolerant.

This segmentation allows us to define product qualities, flavor characteristics, language, and messaging. Using the principles developed through this analysis, wine producers, sellers, and marketers can position wines to appeal to specific segments.

These principles can be applied from the ground up with product ideation and development, or applied to existing products in the market. It is possible to apply these concepts to an entire portfolio of wines to increase the reach of a winery across segments, or alternatively to burrow deeply into the segment that a winery can best serve.

Snapshots of consumer phenotype segments:

Following is a brief description of the four primary phenotype groups and explanations of their physiological sensory sensitivities, purchasing behaviors, and typical wine preferences.

Sweet: People in this segment are physiologically among the most sensitive. They tend to dislike more foods and to be conservative about their wine choices — they stick to what they know. Sweet wine fashions may come and go, but sweet wine consumers are here to stay.

Given the proper products and messaging, Sweet tasters can be sold much more expensive products than conventional wisdom dictates. Properly understanding what these very sensitive tasters want, rather than relying on pervasive misinformation and false assumptions, could pay huge dividends for the wine industry, by engaging and cultivating reticent consumers and offering new areas of opportunity for many producers.

The Sweet market segment is large and under-leveraged — even in our surveys, which primarily capture people who have a positive experience with wine, 21% of women and 7% of men preferred sweet wine. If the wine industry continues to stigmatize sweet wine, these consumers will continue to opt for cocktails and opt out of the wine category. Indeed, Sweet phenotypes drink wine significantly less often than the other segments, and have the least confidence in choosing wines.

Results from the 2010 Consumer Wine

Continued on page 86

ORGANIC CONVENTIONAL

ORGANIC AND CONVENTIONAL GRAPE GROWING IN 2010

DOWNSIDE OF GREEN

BY **Jeff Prather,** OXBOW Wine Merchant, Napa, CA

Kermit, the famous Muppet frog, lamented in his signature song, "It's not easy being green." That was a common thread in the thoughts of many grape growers and vineyard managers in the problematic vintage of 2010.

In a "normal" year there are always plenty of nature's little foibles to deal with, but in a year like 2010 the struggles were so vast, so numerous, so pervasive, so widespread, and so devastating that it became a monumental challenge for viticulturists to successfully handle.

Some did not succeed in the struggle against the cool, moist vintage. Those who had chosen the "green" path found it even more of an uphill battle since the stipulations and agreements often stripped them of some of the most effective tools and weapons to grapple with such a difficult year. Several arrows were missing from their quiver.

In most years organic farming is a viable and effective alternative to conventional farming, with marketing advantages and a concern for the environment and stewardship of the soil.

Fervent organic growers argue that the entire system remains healthier and less prone to problems after a few years of organic discipline. They note that organic farming can prolong the life of a vineyard and delay replanting, which is a huge financial benefit.

Several growers argue that fruit quality also increases by using organic techniques. Some even say growing green is actually cheaper than conventional farming, and that argument continues. Many choose to take their organic efforts a few steps further and utilize biodynamic techniques.

However, in problematic years, being responsible stewards of the earth can lead to some daunting challenges and uneven quality. Even worse, leaving certain practices off the table can lead to reduced crop yields due to unacceptable results in fruit quality. This can have a major economic impact and result in some extremely expensive crop losses.

The 2010 harvest was rife with challenges, the most prominent of which was a lack of heat; it was a record-setting cool year across the entire West Coast. Oregon was perhaps the hardest hit with most of its vineyards on the cooler, wetter western side of the Cascades. Ripeness was a huge challenge and mold reigned supreme.

Even in eastern Washington where the vineyards are planted in irrigated desert, growers were scratching their heads, having never seen a vintage with such tough growing conditions. A well-known Chardonnay vineyard in the Columbia Gorge was sampling Brix in the high teens in late September. There were resigned discussions that the fruit simply would not ripen in 2010 and that the entire vintage might be written off on this hallowed spot. They were not alone.

Throughout Washington, growers asked, "Where is the heat?" Hangtime was going to be epic, but they wondered if they would be harvesting in December. Would the crop ripen even then? What about the rain? Rot? Frost? Freeze? Cabernet ice wine, anyone?

Even in sunny California the daily high temperatures saw record lows, and sugars were crawling, creeping up the scales of the refractometers. It seemed like everything was a month late or more. Veraison

was completing in September in hillside vineyards. When would harvest begin? Or end?

To make things worse, given the extra time on the vine and the freakishly cool conditions, there were untimely, unwanted bouts of rain. Moisture levels in the vineyards were way beyond threshold. Mold and mildew were definitely problems. Rot was inevitable. This was simply not a normal year.

Materials that are permitted by organic certification can manage many of these problems in a typical year, but 2010 turned out to be too much of a challenge for some growers. Many owners and vineyard managers felt their hands were tied by the rules of organic certification that had taken them several years to complete. If they decided to use conventional products prohibited under organic certification, they would need to begin the certification process all over again. That is a tough and costly decision, and in the end, most chose to maintain certification, but suffered the consequences.

I spoke with several growers regarding the problems and challenges they faced in 2010 and whether being "organic" was important to them. Most were quite outspoken about their care for the earth and its stewardship, yet they felt they were taking a more practical approach.

Jim Barbour (owner of Barbour Vineyards LLC in Napa Valley) states frankly, "2010 was by far my coolest vintage I have seen in 30 years of working in vineyards. At one point in the growing season, we were 110 degree days below normal. We only had a couple of days that were in the high 90°s until the end of August. It was the most challenging vintage I have ever worked.

"Powdery mildew was our biggest challenge in 2010. With the cool weather and added moisture in the mornings, we had to constantly fight mold and mildew. To make it even worse, there was no heat to make the organic sprays work. These sprays are heat-activated, and it was too cool for most of them to work. Even sulfur needs heat to work.

"Because of the cool growing season, we were overlapping organic sprays. Instead of every six to eight days, we were spraying every six days. In our conventional vineyards using synthetic sprays, we were able to extend the interval to 18 days.

"The problem with our organic sprays in 2010 was obtaining adequate coverage. Without knowing how cool and moist the summer would be, we chose not to completely remove leaves around the clusters. This reduced the amount of coverage we achieved early in the season. Repeated applications of wettable sulfur and Stylet oil, could not prevent mildew infection completely.

"Mildew pressure was so high all year long we could not get away from it. Some spray materials used in conventional spray programs give much better control because of their mode of action and their ability to be locally systemic, giving them a much longer active life span. Besides Stylet oil sprays and sulfur applications (both wettable and dust), we found other organic treatments to be particularly ineffective.

"To complicate things, in my opinion, since we had to spray so often, I think there was some compound in some of the organic sprays — whether it was clay or something, I do not know — that might have caused the breaking down of grape skins, resulting in shrivel. We did not have this with any of our synthetic sprays. The vineyards where we sprayed synthetics did not have any mildew or mold problems whatsoever."

Barbour continues, with frustration echoing in his words: "In a normal year we only use organic sprays to simplify things, we do not have to recalibrate the sprayers at 2AM in the morning, and we eliminate any possibility of spraying the wrong compounds. But in

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2010, we made the decision to switch to synthetics in conventional vineyards and it made all the difference."

Barbour elaborates on other complications in 2010, "In the middle of this very cool year, to combat mildew and ripen the fruit, everyone pulled leaves, opened up the canopy, and exposed the fruit to air and sunshine. Then we get hit with a 113°F day that sunburned some fruit and, even more serious, caused stem necrosis, which you would not notice for up to several days. Then the cluster just shrivels and dies. But that was true in organic and conventional farming, there was nothing you could do about that. It was a really tough farming year."

Mike Wolf (Michael Wolf Vineyard Services in Napa Valley, CA), confided that 2010 was a "very challenging vintage" for him since he manages several properties for various owners in different locations. "I think the real difference was up-valley. In Carneros, it was slightly cooler than normal and we were a couple weeks behind. But in Calistoga it was dramatically cooler, and harvest was much later."

Wolf agreed that it was "the toughest I have seen in all of my time managing vineyards. Powdery mildew was our biggest problem and was about as bad as I have seen it." In the past, Wolf has had serious discussions with clients about becoming "certified" organic because he was aware of the restrictions he might face.

"I think there is an important difference in being organic and being certified organic," explains Wolf. "It gives you more flexibility. It goes back to that elusive notion of being sustainable. If you lose half your crop that is not sustainable."

In 2010, Wolf became acutely aware of the challenges when he faced such tough conditions with limited resources. Wolf adds, "In certain situations it just does not make much sense being organic — just look at the number of tractor passes through a vineyard you have to make when applying certain organic compounds. It is very costly, uses a lot more fossil fuel, engines burning diesel and leaving exhaust in the vineyards.

"Look what it does to the soil. It compacts the soil a lot more making ten passes instead of four. In one vineyard we had to make 13 or 14 tractor passes. I actually had one client give up his efforts at attaining certification of 52 acres of grapes for environmental reasons. My client said, 'That diesel fuel is really nasty stuff.'"

Wolf's concerns were echoed by several growers I spoke with in Napa and Sonoma. Growers and vineyard managers have had several meetings and there are more upcoming seminars to analyze what happened in 2010 and learn from this tough experience.

Wolf experienced grape skins breaking down and leading to shrivel, perhaps from the copious amount of organic spraying. But he had a different theory about the cause, "I think that it may have been partly due to the repeated use of surfactants, which we also use in conventional spray applications. Since some of the synthetic materials are systemic, the spray intervals can be longer, so less total surfactant is used during the season. The surfactant aids in spray coverage, and may help the materials penetrate the plant, raising my suspicions regarding the breakdown of the grape skins, making them more susceptible to heat damage.""

"95% of the vineyards (approximately 1,000 acres) we manage are farmed organically," says **Mark Neal**. The son of the founder and president of Jack Neal & Son (St. Helena, CA), adds without any hint of bragging, but simply as a confident matter of fact: "We have been farming organically in Napa since 1984. I would say we are highly successful. Not once have we had any issues that we could not handle, even the weather and European grapevine moth in 2010."

Patrick Riggs, a viticulturist at Neal & Son, reports that they did have some crop loss in 2010, but nothing out of the ordinary or uncommon considering the vintage. However, "Make no mistake," he says, "This was an extremely challenging vintage with many difficulties.

"The problem with powdery mildew was widespread in varying

Continued on page 88

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Defining SUSTAINABLE VITICULTURE *from the* PRACTITIONER PERSPECTIVE

BY Matthew Hoffman, Mark Lubell, Vicken Hillis,
University of California, Davis

Sustainability is a central topic of discussion in the viticulture and wine industry. But what is the definition of sustainable agriculture? More important, how can definitions be practically used to help solve the very real ecological, economic, and social problems facing modern agriculture, including viticulture?

Defining sustainability is a challenge, because agricultural systems are complex and dynamic, and involve many stakeholders with different goals and values. For this reason, the question: "What is the definition of sustainable agriculture?" can lead to too much ideological debate and too little action. All the while, agriculture is faced with many economic insecurities, ecological challenges, and social inequities that demand immediate attention.

Definitions have the potential to guide our responses to these problems, but only if they adequately reflect real agricultural needs and realities. By asking, "What definition for what purpose?" we can obtain an action-oriented definition that helps solve real problems.

> Any discussion of sustainability must clarify what is being sustained, for how long, for whose benefit and at whose cost, over what area, and measured by what criteria? —Jules Pretty[1]

Definitions of sustainable agriculture must include what is to be sustained and for how long, for whose benefit, at whose cost, in what geographic space, and by which means. These definitions must also specify how progress will be measured. These questions take agricultural sustainability in context, and their answers provide insight into how to best achieve on-the-ground results.

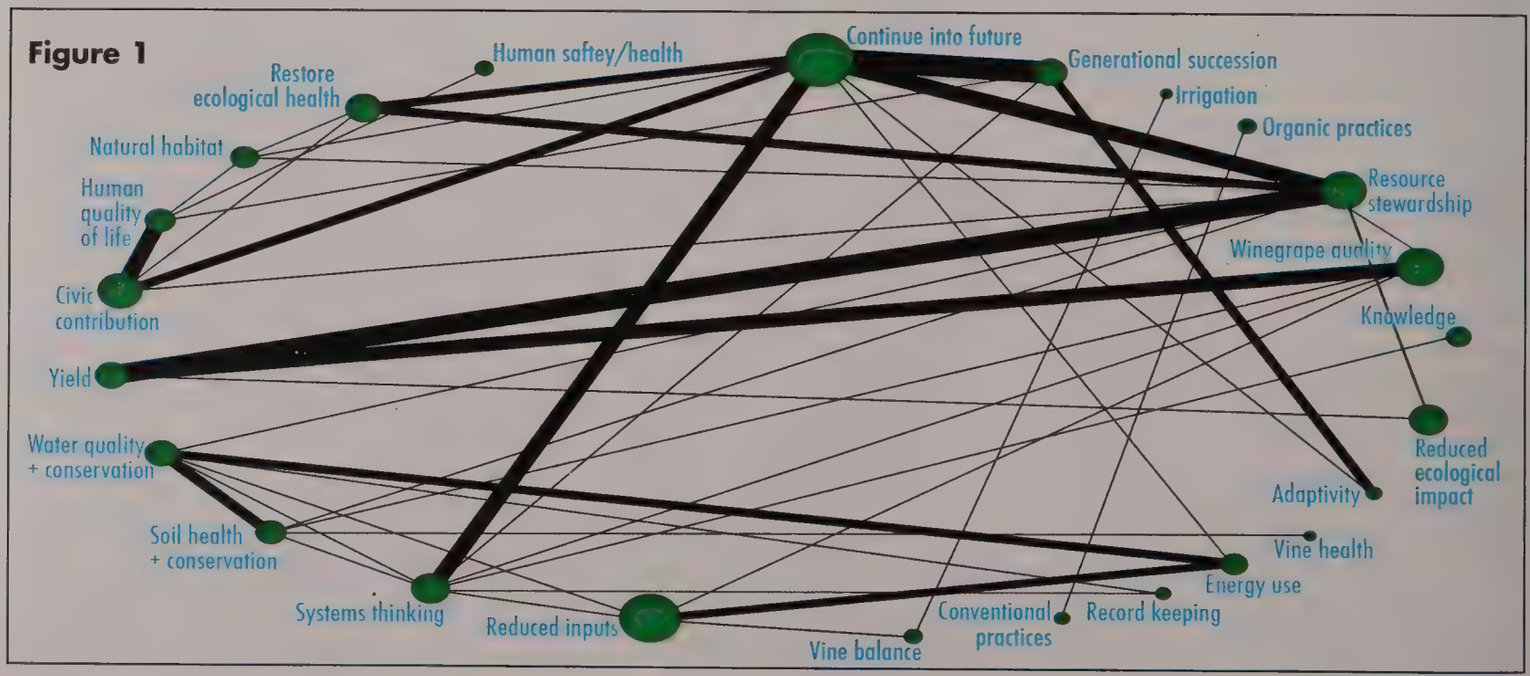
With several well-developed sustainability programs, California is a good place to explore the meaning of sustainability in viticulture. Notable programs with regional focus include the Central Coast Vineyard Team's Sustainability in Practice certification, Lodi Winegrape Commission's Lodi Rules for Sustainable Winegrowing certification, and Napa Green certification. As of 2010, these three programs certified a total of 46,680 acres of winegrapes.

Other programs include Fish Friendly Farming, which focuses on ecological stewardship of viticultural and other agriculture land in the North Coast region. The California Sustainable Winegrowing Alliance has a statewide Sustainable Winegrowing Program and Certified California Sustainable Winegrowing certification.

In California, grower participation in sustainability programs correlates with the increased adoption of sustainability practices[2] and that outreach professionals report such programs to be effective at promoting further adoption of sustainability practices, reducing environmental risks, improving relationships between the viticulture sector and regulatory agencies, and increasing communication among growers.[3]

The findings presented below come from a series of studies that analyzed definitions of sustainable agriculture from two categories of viticulture practitioners: outreach professionals and winegrape growers. Outreach professionals provide management advice to growers and include pest control advisers, extension agents, university researchers, viticulture consultants, producer group staff, and sustainability program staff.

Figure 1



The first study (conducted by the lead author in 2008) analyzed data from interviews with 14 growers participating in the Lodi Rules for Sustainable Winegrowing certification program. The second study (conducted by all three authors in 2010) analyzed data from 108 outreach professionals collected through a California-wide survey and from interviews with 16 growers across the Central Coast, Lodi, and Napa Valley regions. Open-end interview and survey questions asked practitioners to define sustainable agriculture in their own words.

Definitions from the California-wide study were coded to extract themes (shown in Figure 2). For example, the **bold** section in the following grower definition was coded for "civic contribution" (among other themes). "I strive to continually reduce my impact on the environment, treat my employees with fairness and respect, **make a positive contribution to my community**, grow high-quality winegrapes, and make enough profit to be able to live a good life and pass my family farm onto the next generation of agriculturalists in as good or better shape than I found it." Network analysis was used to identify relationships between themes.

Definitions from the Lodi study were qualitatively analyzed to identify relationships between themes, and quantitatively analyzed to produce theme frequencies and distributions.

Three Es of sustainability

Definitions of sustainable agriculture are useful and important, as theories and concepts often end up influencing people's beliefs and actions. In California's viticulture sector, the "Three Es" – economic viability, environmental health, and social equity – are commonly used definitions.

Figure 3 shows the themes identified in definitions collected by the California-wide study ranked by the percentage of respondents who included each theme. The aspects of the Three Es were mentioned more frequently than other theme. Explicit mention of the concept itself was the sixth most frequently mentioned theme. This suggests that the Three Es definition has a strong effect on practitioner thinking about sustainability.

Economic viability is an essential aspect of sustainability

The most prevalent theme in practitioner definitions of sustainable agriculture across both studies is economic viability. "If you are not economically viable, you are not sustainable," says one grower. Another grower adds, "If we are not economically viable, we won't be on our land to farm in the future."

In the Lodi Rules study, all 14 growers addressed economic viability in their definition, and six growers began their definition with economic viability. Results from the California-wide study in Figure I show economic viability to be the most frequent theme at 59%. In the practitioner's view, economic viability is an absolutely necessary aspect of sustainability in modern agriculture.

One grower says, "I think the Three Es is a very useful concept for viticulture on farms of all sizes. I also think it is useful to pretty much anything anybody does because we tend to not look at anything we do as a system; we tend to look at the point or the proximate event that we are dealing with."

Theme network of sustainable agriculture

A theme network[4] conceptualizes how viticulture practitioners define and perceive sustainability. It represents their cognitive framework, which they use to interpret their world and make decisions.

Theme networks consist of "nodes" and "ties." Nodes represent different themes found in practitioner definitions of sustainable agriculture. Ties represent co-occurrence of themes in a given definition. A tie exists between two nodes when they are jointly mentioned in one definition. Theme networks are useful tools to understand the relationship between human cognition and social behavior.

Figure 1 represents the theme network of sustainable agriculture from the California-wide study. The larger the node, the more frequently the theme was mentioned. The thicker the tie, the more frequently the two themes co-occurred.* By observing node size, we see that, continuing into the future, resource stewardship, winegrape quality, reduced environmental impact, reduced inputs, and civic contribution were among the most frequently occurring themes.

By observing the thickness of the ties, we see the following pairs as being among the most frequently co-occurring themes: continuing into the future and generational succes-

** Because the themes of economic viability, environmental stewardship, and social equity are very general, they are removed from Figure 2 in an effort to focus attention on more specific themes.*

Core theme set	Periphery theme set
Adaptively	Biodynamic practices
Civic contribution	Conventional practices
Continue into future	Efficiency
Energy use	Human safety
Generational succession	IPM
Habitat conservation/restoration	Irrigation
Improve ecological function	Knowledge
Reduced inputs	Organic practices
Resource stewardship	Pest control
Systems thinking	Vine health
Water quality/conservation	Quality of life
Winegrape quality	Record keeping and analysis
Yield	Recycling
	Reduced environmental impact
	Regulation compliance
	Soil health/conservation
	Vine balance

Figure 2

sion, continuing into the future and resource stewardship, continuing into the future and systems thinking, resource stewardship and yield, and winegrape quality and yield. Isolated themes that did not co-occur with other themes were removed. Now we can begin to quantifiably understand how practitioners perceive and define sustainable agriculture.

Using statistical methods,[5] we have identified a core set of themes that are more strongly connected to other themes, and a periphery set of themes that are less strongly connected. Figure 2 lists the "core" and "periphery" themes.

Centrality is a statistical measure of the number of ties a given node has to other nodes. Nodes with more ties to other nodes have a higher degree of centrality. Continuation through time was the most central theme. Resource stewardship, systems thinking, yield, generational succession, and water quality and conservation were the next most central themes, respectively.

Continuing through time as an overarching theme

One important theme in practitioner definitions of sustainable agriculture across both studies is the idea of continuing into the future. One grower says: "You have to think long-term."

Figure 1 and Figure 3 show that continuing through time was the fourth most frequently occurring theme. This is interesting considering that a 1996 review of scholarly definitions of sustainable agriculture recommended that if definitions are to be useful for guiding change, they ought to recognize the literal meaning of sustainability – the idea of continuing through time.[6]

According to that study, "Regardless of the merits of goals and ideals frequently incorporated into definitions of sustainability, if the idea of continuing through time is omitted, then those ideals and goals are something other than sustainability."[6]

Lodi Rules growers frame sustainability in terms of generational succession of ownership and management of the family's farm enterprise. One grower states: "I want to see vineyards on my land, and I want to see my kids on my land."

Twelve of 14 Lodi Rules growers who were interviewed stated that sustainability means providing an opportunity for their children to continue farming.

The many generations of Lodi Rules growers' families that have been involved in farming suggest that agricultural legacy is a defining characteristic of the region. Thirteen growers interviewed were from multigenerational farming families, including eleven who have been farming in Lodi during that period. All expressed aspirations to see their family's agricultural legacy continue with the next generation. The mean number of generations in agriculture was 3.5, and the mean number of generations in Lodi agriculture was 2.8.

Ecological health and social equity are viewed as resources for stewardship, and economic viability as a necessary objective, but all three are viewed as playing a cumulative and supporting role in achieving the ultimate goal of generational succession. The California-wide study reinforces this finding. Figure 2 shows the themes of continuing into the future and generational succession are frequently co-occurring themes in practitioner definitions.

Figure 4 summarizes results of our studies and provides a practical framework for sustainability that shows how practitioners perceive relationships between ecological health, economic viability, social equity, and generational succession. Ecological health and social equity provide functions that help sustain economic viability for the long-term.

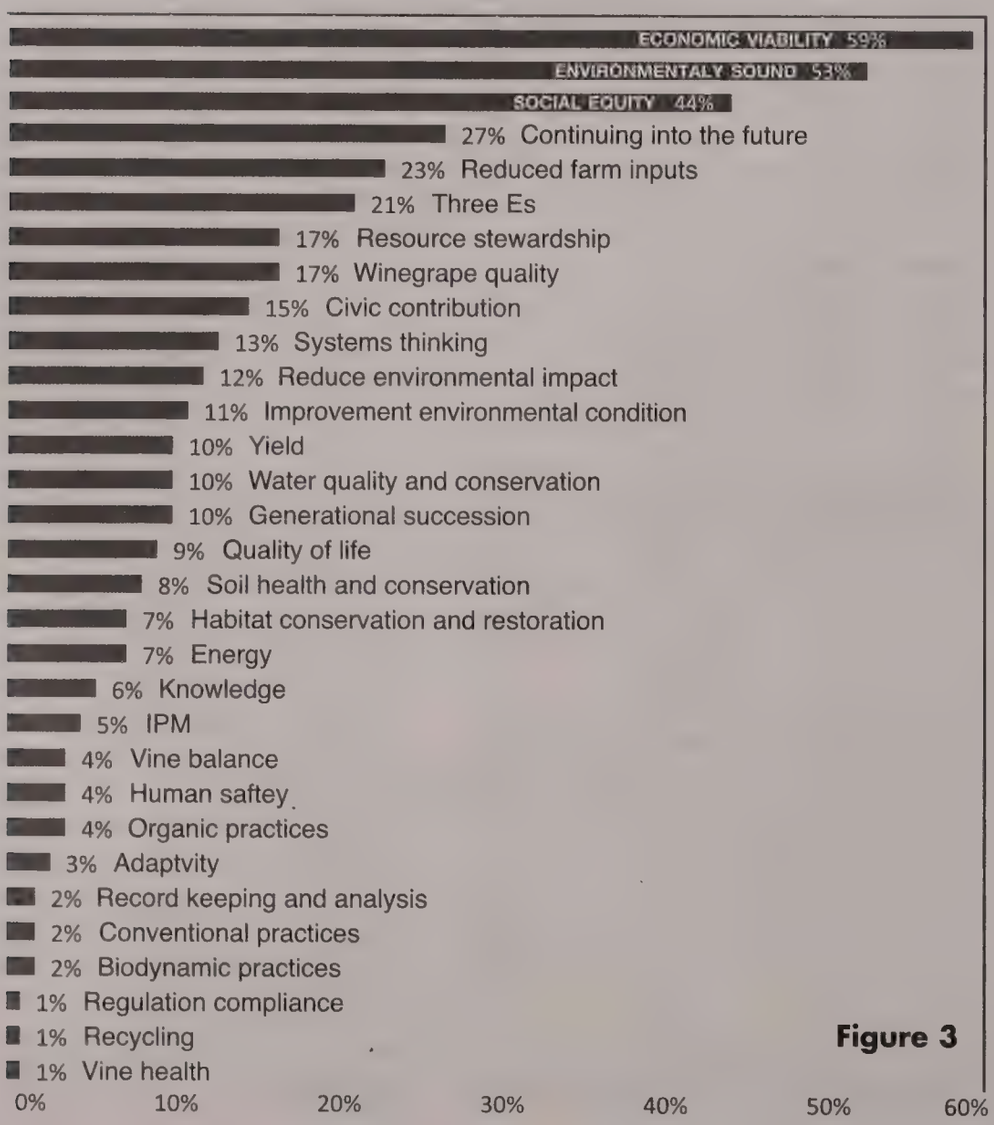
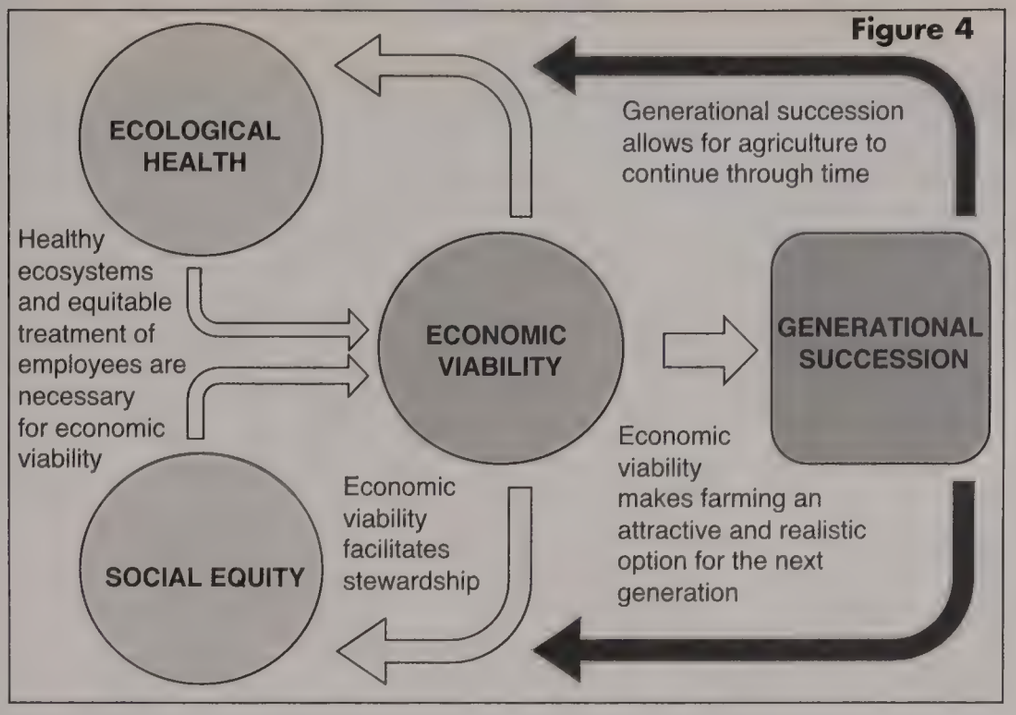


Figure 3

Thirteen growers (from the Lodi Rules study) stated that economic viability enables resource stewardship. They see economic viability as a necessary condition to enable viticulture management to support ecological health and social equity, and for generational succession.

Agriculture is fundamentally a human activity. Therefore, the next generation of farmers is essential. Lodi Rules growers expressed that they wanted to pass on to their children more than a title to their land, vineyards, and equipment. They want to give them an economically viable farm enterprise capable of producing a livelihood. They want to offer their children an attractive and realistic opportunity to continue the family's way of life. The final decision is left to their children, but they take it upon themselves to provide the opportunity.

In one grower's words, "I won't force my children to follow in my footsteps, but I want my kids to have the choice. I had that choice. I want to give my kids the same option."


ECOLOGICAL HEALTH
Generational succession allows for agriculture to continue through time
Healthy ecosystems and equitable treatment of employees are necessary for economic viability
ECONOMIC VIABILITY
GENERATIONAL SUCCESSION
Economic viability makes farming an attractive and realistic option for the next generation
Economic viability facilitates stewardship
SOCIAL EQUITY
Figure 4

Conclusions

Definitions of sustainable agriculture are more useful if they are oriented toward action. We have explored the meaning of sustainability from the practitioner's perspective with the hopes of grounding the sustainability discussion in real needs and realities. We shed some light on how viticulture practitioners would answer the questions about what is to be sustained, for how long, for whose benefit, at whose cost, in what geographic space, by which means, and how progress will be measured. For this reason, this report reflects the views of California growers and outreach professionals. Other perspectives including those of environmental and human rights interest groups, to name two categories, must also be considered.

We end with three of many recommendations that could come from our analysis of practitioner definitions. We encourage *PWV* readers to draw additional conclusions.

First, theme networks of sustainable agriculture are potential tools for outreach and education programs, and for practitioners themselves, to better understand and evaluate underlying assumptions that implicitly guide decision making around sustainability in winegrape growing. They can be used to identify knowledge gaps in practitioner understanding of sustainability that may differ from scientific understanding, thus pointing to a need for dialogue and sharing knowledge among scientists and practioners.

Second, groups in conflict can use practitioner definitions as communication and cooperation platforms. According to T. Tomich *et al.*, "Developing a shared conceptual framework may generate dialogue among groups with different assumptions, ways of understanding, and approaches to managing dynamic natural and social systems."[7]

Sustainability means different things to different people, and conflict often arises when stakeholders cannot agree on an agenda. However, this does not diminish the need for effective communication and cooperation, despite tensions. Definitions can guide effective problem solving only if they span divides between groups arguing over contentious issues.

To do so, definitions must possess three characteristics: SALIENCY to practitioners ("Is it relevant?"), CREDIBILITY with regard to scientific and practical understanding of agriculture ("Is it sound and convincing?"), and LEGITIMACY in the eyes of stakeholders ("Is it inclusive and unbiased?").[8] The central and core themes are likely to be the most salient, credible, and legitimate to viticulture practitioners.

Central themes have higher potential as starting points that may lead to broad discussion of important sustainability topics (Figure 2). Dialogue about vine balance may only spur discussion about reduced inputs and irrigation.

In contrast, dialogue around resource stewardship may lead to a much broader discussion about continuation into the future, improving ecosystem function9, natural habitat, civic contribution, yield, water quality and conservation, reduced enological impact, and winegrape quality.

Core themes have the greatest potential relevance to practitioners across political or other differences. Continuing into the future with a focus on generational succession, resource stewardship, and systems thinking may be the strongest platforms for cooperation. These applications, and any others taken from the results presented here, are useful for viticulture outreach and education programs that assist practitioners who are addressing changes in sustainability.

Continued on page 89

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SPRING 2011

VINEYARD SHOWCASE

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e-mail: bborboa@oxbocorp.com
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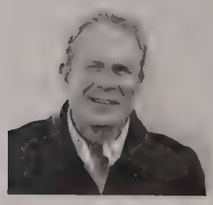
PLEASE SEE OXBO AD, PAGE 25.

WESTERN SQUARE INDUSTRIES



In 2011, Western Square introduces an expanded sales team, adding the winery, cooperage, and vineyard expertise of Raymond Willmers (left). Willmers comes to Western Square with an extensive background in the industry. One of the founders of Mendocino Cooperage, he has also served as National Sales Manager of a well-known winery in Healdsburg. Expanding vineyard aspects of the sales team is Tony Vaccarezza (right), who adds agricultural experience.

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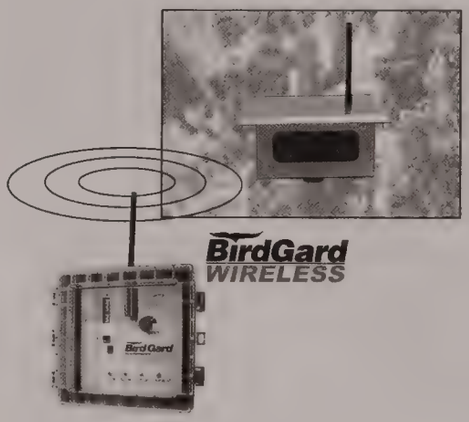

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premiere

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Maps, lab reports, aerial images, and all of the other random papers go in one place for easy future access.

PremiereVision© includes spraying, fertilizing, irrigation scheduling with built-in optional ET calculations, weather degree day tracking, wine-quality feedback, crop estimation, growth monitoring, pest monitoring, irrigation monitoring, block specifications, and nutrient tracking.

PremiereVision© software highlights:

Quickly view and manage all critical vineyard activities;

Time-saving work orders;

Simple, powerful web-based, real-time database;

No software to install — all data on secure servers, view from any location with a password;

Use iPhone, Blackberry, Droid, or iPad for full access in the vineyard;

Pricing is on a sliding scale, and there are three levels to choose from — see rates on website.

PremiereVision© (patent pending) is the vineyard database designed by and for viticulturists.

For more information or a demo, contact:
Premiere Viticultural Services, Inc.
1795 Third St, Napa, CA 94559
tel: 707/927-5182
website: www.premierevit.com

PLEASE SEE PREMIERE VITICULTURAL SERVICES AD, PAGE 24.

DOW AGROSCIENCES LLC

New vineyard plantings should provide decades of productivity. Considering the massive undertaking and expense of planting a new vineyard, soil fumigation is strongly advised where nematodes or "replant disease" are present.

Soil fumigation using Telone(r) soil fumigant creates a zone of protection around roots, allowing them to develop in an environment where nematodes are controlled and soil-borne diseases and viruses (such as grape fanleaf virus) are managed. The result: extensive, healthy root systems capable of producing decades of high-quality, high-yielding grapes.

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The increased growth provided by Telone(r) (compared to untreated) is so dramatic that the cost of fumigation is often paid for with the first crop harvested. Plus, starting vines with a healthy, strong root system leads to many other benefits such as generating early growth response, promoting plant longevity, creating more efficient use of water and fertilizer, and allowing for more rootstock choices.

To order the FREE guide, *Managing Nematodes and Replant Disease in Orchards & Vineyards*, call 888/395-PEST.

For more information, contact:
Dow AgroSciences LLC
9330 Zionsville Rd, Indianapolis, IN 46268
tel: 888/395-PEST
e-mail: info@dowagro.com
website: www.dowagro.com

California Seed & Plant Lab

California Seed and Plant Lab (Cal-SPL) located near Sacramento, CA, offers plant disease testing and genetic identification of grapevine varieties. The firm, established in 1995, employs a highly qualified technical staff, including Ph.D. and MS scientists.

Disease diagnosis: Cal-SPL offers a 17-virus PCR test to identify all viruses known to be present in California vineyards. Growers can identify healthy vines and start new plantings from healthy vines. Other economically important diseases including young vine decline (*Phaeoacremonium spp*) are also identified.

Virus elimination: Cal-SPL offers meristem services to eradicate virus infections from your favorite cultivar.

Soil health: Cal-SPL offers analysis of soil and enumerates beneficial microorganisms to such important pathogens as *Agrobacterium* (crown gall) and *Cylindrocarpon* (root rot). The analysis helps growers to choose a suitable organic amendment or compost tea to incorporate into soils for maximum yield.

Variety DNA identification: Genetic testing includes fingerprinting of varieties with an 8-marker DNA test. The fingerprint is compared with the varietal database (Cal-SPL has all varieties grown in California in the database). Fingerprinting service can also provide genetic profiling for patent applications.

For more information, contact:
California Seed & Plant Lab
7877 Pleasant Grove Rd, Elverta, CA 95626
Parm Randhawa, Ph.D.
tel: 916/ 655-1581; fax: 916/655-1582
e-mail: randhawa@calspl.com
website: www.calspl.com

PLEASE SEE CALIFORNIA SEED & PLANT LAB AD, PAGE 48.

Advanced Viticulture, Inc.

Advanced Viticulture, Inc. is a wine-growing consulting company that operates from a standpoint of sustainability. Operated by principal viticulturist Mark Greenspan, Ph.D. with a philosophy of minimal inputs to the vineyard, Advanced Viticulture achieves environmental protection, while allowing each site's uniqueness to be expressed in the wine. Reduction of fertilizer and irrigation inputs allows the vineyard's characteristics to shine through.

Advanced Viticulture offers turn-key monitoring services for irrigation management, which includes installation of soil moisture data logging systems, frequent measurement of plant water status, and weekly updates. Updates include current moisture status and water management advice. Service packages may be limited to water management, or may include other aspects of sustainable viticultural practice. Moisture monitoring equipment is also available for sale and lease.

Advanced Viticulture employs the SIS™ Soil Information System to create detailed soil maps. Advanced Viticulture interprets the information to develop recommendations ranging from detailed vineyard design, to irrigation system modifications, to remediation and improvement of existing vineyards.

Every vineyard, grower, and winery is unique. Advanced Viticulture understands that and works with each client to provide custom-tailored advice based on unique needs and goals. Advanced Viticulture can be engaged for a brief diagnostic visit, a defined project, or an ongoing advisory arrangement. Projects and pricing structures are tailored to match each client's goals and budget.

For more information, contact:
Advanced Viticulture, Inc.
Mark Greenspan
930 Shiloh Rd, Bldg 38B, Windsor, CA 95492
tel: 707/838-3805
e-mail: info@advancedvit.com
website: www.advancedvit.com

PLEASE SEE ADVANCED VITICULTURE AD, PAGE 38.

Agajanian Vineyards

Agajanian Vineyards, wine grape merchant and bulk wine negociant, provides a variety of services to satisfy its customers' various needs.

AGAJANIAN VINEYARDS

Winery Services: Wine Grape Procurement: Agajanian Vineyards assists in finding exceptional values on wine grapes throughout California on a brokerage or full-service basis, and helps assure customers the grapes to fulfill market demand.

Grower Services: Grapes for Sale Listing: Available wine grapes are listed and, once contacted by winery clients, the Agajanian Vineyards' data base will be accessed for a match (no charge).

Grape Marketing: To find the best possible market for wine grapes, list the grapes as above, and Agajanian Vineyards will actively market the grapes by:

- Presenting grapes in a professional manner to wineries throughout North America;
- Promoting the grapes through advertising, fax, and email campaigns;
- Direct mail, telephone, and personal meetings;
- Saving customer-time finding qualified buyers;
- Giving customers market feedback;
- Assisting customers with long-term planning.

For more information, please contact:
Agajanian Vineyards
North Coast: Rick Aldine
cell: 707/287-6073
Northern Interior: Daniel Garcia
cell: 916/425-6656
Central Coast: John Tufenkjian
cell: 805/975-7001
California: Gary Agajanian
10174 Highway 41, Madera, CA 93636
cell: 707/480-0474
e-mail: gary@agajanian.com
website: www.agajanian.com

PLEASE SEE AGAJANIAN VINEYARDS AD, PAGE 38.

SUREHARVEST, INC.

SureHarvest Farming MIS is a powerful software tool to increase efficiency, conserve resources, cut costs, and improve quality by providing growers with access to data to make better-informed and more timely farming management decisions. With SureHarvest Farming MIS, growers can plan, schedule, record, analyze, and report all vineyard activities including scouting; sampling and food safety; chemical-fertilizer applications; irrigation; yield forecasting; harvest, and labor.

SureHarvest Farming MIS has six activity-based modules that can be purchased as a system or separately. SureHarvest is now offering a solution for managing grower relations by integrating Farming MIS with a customer's production, contract, inventory, and financial management systems, such as Oracle. By providing data collection tools for grower reps, companies can extend SureHarvest technology to contract growers for improved yield estimation and quality management.

Since 1999, SureHarvest has been a leading provider of sustainability software and consulting services to the California wine industry. SureHarvest was a key architect of the California Code of Sustainable Winegrowing Workbook, enabling 68% of California's vineyards and wineries to conduct self-assessments of 227 sustainability practices. The SureHarvest Sustainability MIS powers the Sustainable Winegrowing Program with on-line self-assessment and benchmark reporting. SureHarvest also manages the *Protected Harvest* eco-certification program, used by Lodi Rules.

SureHarvest
SUSTAINABILITY FROM THE GROUND UP

For more information, contact:
SureHarvest, Inc.
2901 Park Ave, Ste A2, Soquel, CA 95073
tel: 831/477-7797; fax: 831/477-7790
e-mail: sales@sureharvest.com
website: www.sureharvest.com

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ASSOCIATES INSECTARY

Associates Insectary has provided practical, cost effective options for mealybug control since 1928. The growers' cooperative is the oldest producer of beneficial insects in the U.S.

High quality beneficial insects are shipped directly to a customer's vineyard from Santa Paula, CA, arriving healthy due to short travel time.

The use of beneficial insects may not replace the use of all pesticides, but these good bugs are an additional "tool" for growers to use. They can provide a cost-effective way to reduce pesticide use while reducing pest problems. When used in combination with mating disruption, both methods become more effective.

ASSOCIATES INSECTARY
Since 1928

Associates Insectary raises a highly specialized parasitic wasp known as *Anagyrus pseudococci*, which attacks **only** young vine mealybugs. These wasps are best at searching for vine mealybugs living under the bark in the Spring.

Associates Insectary grows "mealybug destroyer" (*Cryptolaemus*) beetles. These aggressive predators feed on many types of mealybugs, devouring thousands of them later in the season. The insectary has begun growing brown lacewings to provide general predators for early Spring.

Although general guidelines exist, the correct timing and quantity of beneficial insects required should be determined by a knowledgeable consultant or Pest Control Adviser (PCA).

For more information, contact:
Associates Insectary
Brett Chandler
PO Box 969, Santa Paula, CA 93061
tel: 805/933-1301
e-mail: info@associatesinsectary.com
website: www.associatesinsectary.com

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BIRD GARD

Bird Gard is a world leader in electronic bird control, with millions of vineyard acres protected worldwide, not to mention airports, livestock operations, marinas, and power stations.

The most efficient and effective way to eliminate bird damage is to deal with thieving birds in terms they can understand. Unlike harassment and hazing devices, such as cannons and pyrotechnics that attempt to startle or annoy birds into leaving, Bird Gard uses digital recordings of actual bird distress calls, and the sounds of their natural predators, to send an unmistakable message to the unwanted dinner guests: they are next on the menu!

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When birds come in range of a crop protected by Bird Gard they immediately change course out of fear they are in real danger, and find somewhere else to dine.

Bird Gard is a one-time investment of less than $200 an acre!

For more information, contact:
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PO Box 1690
270 E Sun Ranch Dr, Sisters, OR 97759
toll-free: 888/332-2328; fax: 541/549-5286
e-mail: info@birdgard.com
website: www.BirdGard.com

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Market Segmentation

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Awards at Lodi, CA (CWAL) show much more agreement about what constitutes great wines among Sweet tasters than among other segments. The top three scoring wines, and an inordinately high percentage of Platinum Awards, were **all sweet!** This result does not mean that sweet wines are superior. It does provide insight that sweet wine drinkers seem to be more in agreement about the qualities they prefer in wines than dry wine consumers.

When they drink wine, members of the Sweet segment drink White Zinfandel, fruit wines, Sangria, or Lambrusco. Simply put, these consumers are highly sensitive tasters who want sweet tastes to mask bitterness and alcohol — higher alcohol content not only increases the sensation of burn for these consumers, but it also increases the perception of bitterness.

Their preference for sweetness extends to other bitter beverages — if you take away cream and sugar for their coffee they will simply stop drinking coffee, just as they will stop drinking wine in situations where dry wines are *de rigueur*, as our research shows.

In our most recent survey, we asked about the appeal of different types of wine descriptions. Sweet consumers have no use for the point system for judging wines, but are more interested than consumers of the other phenotypes in awards, in information about wine and food pairing (they are the least confident segment about this process), and especially in advice from others with the same taste in wine.

The direction to take for Sweet consumers is toward wine with 3% to 6% residual sugar, impeccably made, and toward promoting these wines with the foods that they eat on a regular basis. Also, do not forget to give them confidence in their good taste when they choose sweet wines!

An even bigger opportunity exists in restaurants and bars, where these consumers usually migrate to beer and cocktails rather than wines — give them the opportunity to feel secure and proud in their wine choice, and they may migrate back!

HYPERSENSITIVE phenotypes comprise the largest segment in our studies, 36% of men and 38% of women. Like the Sweet phenotypes, Hypersensitives live in a vivid and intense sensory world of taste, smell, light, touch, and sound. They avoid strong flavors and are physiologically predisposed to find more intensity and complexity in wines that less sensitive tasters — especially the Tolerant crowd — deem "too light" and "weak."

For Hypersensitives, high alcohol levels burn, and bitterness is extremely unpleasant, which also explains the fiercely differing opinions between Hypersensitive and Tolerant wine critics about alcohol levels and intensity for many wine styles.

Hypersensitives love the flavors they experience from Pinot Grigio, and really appreciate the trends that provide slight sweetness in traditionally "dry" wines like Chardonnay, Sauvignon Blanc, and some red wines. They are also favorably inclined to love Riesling in the 1.2% to 2.5% residual sugar range, and light, fragrant red wines that are low in alcohol and devoid of the reductive or other aromas that constitute "complex" wines for less sensitive tasters.

This group could be very receptive to rosé wines, but the drive to make them more "serious" (reductive aromas, oak ageing, etc.) makes these wines less pleasurable for this group. Red wines must be impeccably crafted and lighter in intensity and alcohol levels, and phenolics and acidity must be carefully kept in a delicate balance.

SENSITIVE consumers comprise about one-quarter of our survey respondents. They are by far the most compliant segment because of their predisposition to enjoy a wide range of flavors. They will be satisfied with more delicate wines, yet are also able to tolerate, if not fully enjoy, the full-blown, high intensity wines of the Tolerant world.

It is very likely that early in their learning about fine wines, they may be lured to the simplicity of the 100-point rating system and the "more is better" way of comparing wine value, only to tire of high intensity, tannins, and alcohol over time. As they grow more confident they will seek wines that they consider **better balanced** (relative to their standards of balance) and less overblown and over-the-top.

The **TOLERANT** segment is two-to-one male: 32% of men and 16% of women in our study. Clearly the red wine set, Tolerant consumers love intensity in wine, and are often able to appreciate many flavors that more sensitive tasters find intolerable, such as Cognac, Scotch, strong black coffee, cigars, and big red wines. They measure experiences by the standard of "the bigger the better," and the 100-point system of rating wines makes better sense to Tolerants than to other segments.

Tolerants find that high levels of alcohol taste "sweet" and seem to be oblivious to high levels of bitterness and tannin. Tolerants are currently the "aspirational" segment, as current practices in wine merchandising promote wines that appeal to these consumers. Yet interestingly, this is **not** the segment with the highest percentage of wine professionals. In fact we have discovered that a larger than expected number of wine professionals secretly find themselves in the too-often despised Sweet segment.

Take-home messages

No one wine suits all people all the time, but we can improve how to segment the market, target wines to reach specific segments, and in many cases, remove stigmas or arcane wine and food messages that drive consumers to other beverage choices. This means returning sweet wine to a place it has occupied for centuries: the table. It also means allowing people who love big red wines to feel completely at ease enjoying a glass of the wine they love the most with their sushi or shrimp cocktail — a combination they may savor with relish.

Members of each of the identified segments — Sweet, Hypersensitive, Sensitive, and Tolerant — have their own boundaries for flavor preferences in wine, and feelings about the overall experience of wine that influence their engagement in the purchase and consumption of wine.

Taste sensitivity is truly a deeply personal quality, and no one sensitivity is "better" than another, just different. Taste sensitivity is also tied to flavor preferences, personality traits, and consumer behaviors. Appreciating and understanding

these differences will help finely tune your wines and message to potential consumers.

If you learn to target your marketing and to sell your wines according to consumer physiology and psychology, you will increase your chances of pleasing consumers, and by truly pleasing them, you will increase your chances of success. ■

About the Consumer Wine Preferences survey:

The data presented in this report come from an online survey conducted in conjunction with the 2010 Consumer Wine Awards at Lodi and sponsored by the Lodi Tokay Rotary and the Diversity Wine Awards LLC.

Because we were interested in consumers, those respondents who had a professional association with wine were excluded from the analysis. This survey was the third in a series, with over 14,000 total respondents from 2002 to present.

Statistics of the survey:

Collection period:
December 2009 - March 2010
Total starting survey: 1,597
Survey response total for analysis: 1,485
Wine professional participants excluded from survey: 573
Total participants in this analysis: 912

About the authors

Virginia Utermohlen MD *grew up in a multilingual household, where the appreciation of good wine and good food was a given. After passing her French Baccalaureate exam with honors (one of the potential questions was "Describe the wines and cheeses of France!") she turned her attention to the sciences, and completed a medical degree and board certification in pediatrics.*

The mysteries of flavor perception were, however, never far from her thoughts. Her position in the Division of Nutritional Sciences at Cornell University gave her the opportunity to explore the science behind individual differences in flavor sensitivity, and their consequences for food choice, eating attitudes and behavior, and engagement in visual experience (of wine labels, for example). She has left her faculty position to devote herself full-time to exploring and writing about taste and taste sensitivity, with particular attention to wine.

Tim Hanni MW *is a wine industry consultant working with wine producers and hospitality companies in areas of product development, education/training, marketing strategies, and consumer insights. He has worked in the wine industry for 35 years and is one of the first two resident Americans to successfully complete the examination and earn the Master of Wine credential. He is a professionally trained chef and a Certified Wine Educator accredited by the Society of Wine Educators.*

Hanni is respected for his unique perspective on food and wine combined with his work on developing a better means for understanding consumer wine preferences, attitudes, and behaviors. He has lectured in 27 countries around the world on the topics of flavor balancing, sensory sciences, and wine and culinary history.

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Downside of GREEN

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degrees throughout Napa Valley. This is something everyone dealt with in 2010, with many considering it one of the worst powdery mildew seasons in a very long time."

Yet, he mentions that Jack Neal & Son was able to manage and control the problem with products that are approved by California Certified Organic Farmers (CCOF) and the National Organic Standards Board/ U.S. Department of Agriculture.

"We have lots of experience farming organically and had good results in controlling powdery mildew in 2010," adds Riggs. "The mildew pressure was very high and we had to spray more frequently than normal, but it was not excessive in our opinion, only what was required for the growing season.

"It is a matter of adjusting your spraying frequency and coverage (gallons per acre) based on mildew pressure from the UC Davis Gubler-Thomas Model. It is pretty standard practice."

When asked about grape shriveling as a result of spraying with the organic compounds he responds: "We have never had any experience of shrivel being caused by organic sprays. The problem of shrivel (or rather sun burn or sun damage in 2010) happened when we went from 82°F to 115°F in under two days after everyone opened up the vine canopies, but that was a problem everyone had, conventional and organic farmers throughout the entire North Coast."

When Mark Neal was asked about the correlation of shrivel with excessive organic compounds due to spraying frequency, he reacted in a puzzled manner: "I have never heard of or seen anything like that. There are many variables out there that can affect fruit health — soil type, rootstock, water absorption/uptake (translocation or transpiration) rates — but mostly it was vine row direction in those heat spikes that caused the problem.

"I do not think it had anything to do with the amount of spray on the fruit. The causes of bunch stem necrosis are as of yet unknown, but it occurs in both organic and conventional vineyards throughout Napa and Sonoma counties.

"Maybe, since veraison was so late, some people who had late powdery mildew infections sprayed late into the season and hit the heat spikes. Depending on what material they were using, that could have caused a problem."

Neal had a similar reaction when asked about the problem of lack of heat for activation of the organic substances: "We had no problem with that and we farm from Rutherford to Howell Mountain, which is pretty cool, and we had no experience with lack of heat for the compounds to work. I am not criticizing anyone's farming, I just think there may be a learning curve involved with the tools that are available. Maybe they need to look in their toolbox for the right tool.

"There is so much more available to the organic farmer than when we started farming organically in the 1970s. With all we have to work with, we are looking for generations of health, not just in vineyard longevity, but in soil health. We want to be farming and living with these same soils generations from now.

"Today, I think that all of Napa Valley could be farmed organically. In 1984, I wondered how we could do it in Rutherford and Oakville. We have so many tools today that now we are in the mountains and canyons and many more wild places and we are successful everywhere."

Neal summed up his thoughts on the vintage in general: "In 2010, it took a well-seasoned company with lots of experience that was not too thin in equipment and manpower in order to adequately cover every acre you were farming frequently enough to be successful. If you did not throw an extra sprayer or two and some more people at all the various problems you were in real trouble."

Chad Johnson (partner in Dusted Valley Vintners and Boomtown Winery in Walla Walla, WA) talked about his agricultural choices: "We live in our vineyards and our kids run around and play in them, so we are very sensitive to how we handle the farming. We farm for the future of the soil, but we are not afraid to spray when needed. We are not nozzleheads, but if we need it we use it."

He went on even more passionately, "There are Champagne vineyards that have been sprayed with so much copper they do not produce anymore, and that stuff is considered organic."

He continued with a somewhat unfair jab at the organic movement, but it was a very frustrating year: "Hey, we know apple growers who are organic and they sell their good-looking fruit to the normal channels and send the bruised and blemished stuff to organic grocers because they accept it. They are used to it."

Rick Small (owner/winemaker of Woodward Canyon, Walla Walla, WA), was heartfelt in his concern about the dilemma: "Sustainability is a good thing, it will pay off in the long-term, in longer vineyard life." Then there was a large BUT: "We are sustainable. We were organic in 2009, basically in our practices, we were much stricter in the way we handled the vineyard, which set us up for a larger leafhopper population in 2010. They got a good foothold. I did not see many ladybugs in 2010, even though we are organic for the most part. It is a delicate balancing act."

As a vineyard and winery owner, Small is adamant that his company has to be economically viable and be successful. "There are costs involved both in money and in vineyard practices. Grapes get more expensive."

Others were fairly blunt in their answers and in their farming practices. **Ryan Johnson**, one of the highly-regarded vineyard managers (Ciel du Cheval, Delille Grand Ciel, Galitzine Estate) in Yakima Valley and the Red Mountain area and a partner in Grand Reve: "I think our particular farming approach is very pragmatic. I love that in the U.S. we are free to farm the way we choose. The problem I have is when someone tells me they have the ONLY and BEST way to express a vineyard's terroir, and that I will therefore need to spray ground-up dandelions on the vines to harness the power of Jupiter."

Hugh Shiels (owner of DuBrul Vineyard in Yakima Valley, WA)

echoed some of his fellow growers' sentiments about freedom of choice and practical decisions: "Sustainability also means economic sustainability and protecting my vines is important. I do not want someone on a certifying board in another country telling me what I cannot use to protect my vineyard. They do not have the same issues we have in eastern Washington. Come and farm my land for three years with me and then we will talk."

One example Shiels used to make his point was: "There is an application you can use to control mealybugs. I was told by a fellow in France I could spray it, but I was not allowed to apply it through drip irrigation. First of all, they do not have drip in France; it is illegal, so of course he does not sanction it. Even more important, spraying does not work as well and it has a bigger impact, burning fuel and compacting the dirt."

Then Shiels cites an example of practicality: "The application can affect the bees and we have an orchard next door that uses bees, so we wait to use the stuff until the bees are gone. They move them out after pollination. We do not spray it, we drip it, and then we only have to use it once per year. That seems a lot safer."

Shiels has related that, after long discussions with groups of growers in eastern Washington and western Oregon, the certifying body in France changed several of their stipulations regarding approved practices in vineyard management. Due to these accommodations, Shiels is reapplying for certification as a Sustainable Grower.

It is good to see that some certifying bodies are flexible and take the different conditions of various growing regions into consideration.

The issue of control, of what is allowed and what is prohibited, will continue to be a volatile point with many owners and growers, even in vintages that do not prove to be as challenging as 2010.

The proponents of "green farming" have legitimate points and happily subscribe to those practices, and there are others who would prefer to have a free hand at handling problems as they arise.

The over-riding point is that this is all voluntary. We are not mandated by a federal or state agency to adhere to one set of rules or another. As Ryan Johnson so patriotically notes: "... We are free to farm the way we choose."

Conclusion

Whatever choices are made, whatever certification is achieved, whatever governing body oversees those certifications, a grower's mind just might change. A certification might be abandoned, or conventional farming might be dropped in favor of a stricter, cleaner discipline.

As we continue to learn more about the intricacies of farming, soils, soil health, beneficial microbes and insects, irrigation, pest control, weed management, and all of the many aspects of managing a vineyard, it is certain that any and every approach must share an element of practicality and pragmatism.

All of the varied disciplines will surely continue to learn from each other and the healthy debates will also continue. We can truly hope that if the terrible growing conditions of 2010 visit us again, hopefully very infrequently, the lessons we have learned will help us cope with the challenges.

In any case, if again faced with such tough choices and challenging circumstances, whatever decisions are made will have one goal in common: to make the best wines possible in the most responsible way possible. ■

Sustainability

Continued from page 77

Finally, the practitioner's focus on continuation into the future and generational succession brings attention to the importance of who will be farming in the future. What can we do to counter the national trend of a decreasing number of farmers and increasing farmer age?

Succession planning is critical for ushering in the next generation of farmers. However, research suggests that the California wine industry is ill-prepared for succession.[9] A majority of California wineries foresee ownership transitions in the coming decade, but a majority of those wishing to maintain family ownership are unprepared to transition the business to the upcoming generation.

In this report, we have discussed intra-familial succession, but equally important is supporting the entry of first generation farmers. Sustainability programs, like those mentioned above, can help meet the succession needs of winegrape growing families, and those wishing to enter viticulture, by including succession and entry services in their outreach agendas, and by explicitly adding succession planning and apprentice or intern programs to sustainability workbooks and certification criteria. ■

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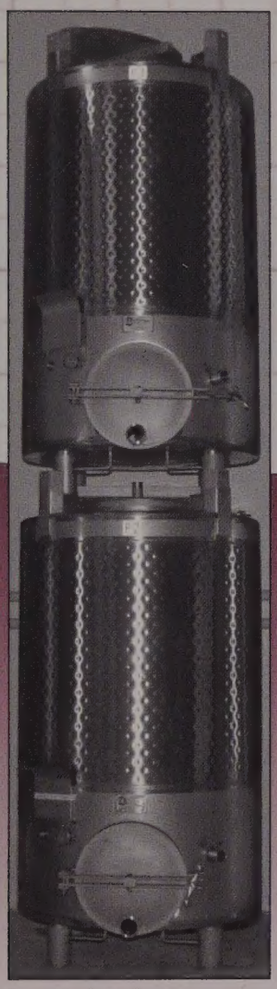

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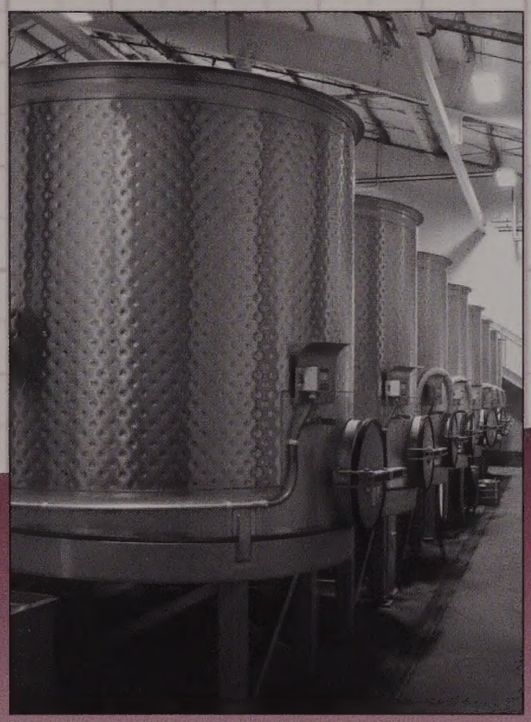

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